NC DEPARTMENT OF
NATURAL AND CULTURAL RESOURCES

North Carolina Museum of Art

Project Manual

Specifications and Other Documents
for

NC Museum of Art East Building and Museum Park Improvements

North Carolina Museum of Art

2110 Blue Ridge Road, Raleigh, NC 27607
SCO ID # 22-25283-02A

Issued for Bid
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North Carolina Department of Natural and Cultural Resources
North Carolina Museum of Art

SCO ID # 22-25283-02A
HH # 22-028

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GENERAL CONDITIONS OF THE CONTRACT

STANDARD FORM FOR CONSTRUCTION MANAGER-AT-RISK PROJECTS

NORTH CAROLINA

DEPARTMENT OF ADMINISTRATION

STATE CONSTRUCTION OFFICE

Form OC-15CM

This document is intended for use on State capital construction projects and shall not be used on any project that is not reviewed and approved by the State Construction Office. Extensive modification to the General Conditions by means of "Supplementary General Conditions" is strongly discouraged. State agencies and institutions may include special requirements in "Division 1 – General Requirements" of the specifications, where they do not conflict with the General Conditions.

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GENERAL CONDITIONS OF THE CONTRACT

The use or reproduction of this document or any part thereof is authorized for and limited to use on projects of the State of North Carolina, and is distributed by, through and at the discretion of the State Construction Office, Raleigh, North Carolina, for that distinct and sole purpose.

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ARTICLE 1 - DEFINITIONS

a. The **contract documents** consist of the Request for Proposal (RFP); Construction Manager's formal response to the RFP; General Conditions of the Contract; special conditions if applicable; Supplementary General Conditions; the drawing and specifications, including all bulletins, addenda or other modifications of the drawings and specifications incorporated into the documents prior to their execution; the contract; the performance bond; the payment bond; insurance certificates; the approval of the attorney general; and the certificate of the Office of State Budget and Management. All of these items together form the contract.

b. The **Owner** is the State of North Carolina by and through the agency or institution named in the contract..

c. The **designer** or **project designer** means the firm or firms of architects or engineers or both (and their consultants) which have undertaken to design the project pursuant to a contract with the Owner, (hereinafter, the "design contract").

d. The **Construction Manager-at-Risk (CM) accepts a relationship of trust and confidence between himself and the Owner and undertakes to act as the Owner's fiduciary in the handling and opening of bids in accordance with the provisions of North Carolina General Statute (N.C.G.S.) 143-128.1.** The CM agrees to furnish his best skills and his best judgment to cooperate with the Owner and Designer for undertaking all necessary action contemplated under the contract documents to (a) establish during the design phase a Guaranteed Maximum Price (GMP) to construct the project and (b) ensure timely and quality completion of the project at a cost within the GMP. Construction Manager or CM as used in the contract documents means Construction Manager-at-Risk (CM at Risk).

e. A **subcontractor**, as the term is used herein, shall be in the case of a principal trade contractor, a general, mechanical, electrical or plumbing contractor or in the case of a specialty contractor, a trade contractor who is not a principal trade contractor, who has entered into a direct contract with a CM, and includes one who furnishes materials worked to a special design in accordance with plans and specifications covered by the contract, but does not include one who only sells or furnishes materials not requiring work so described or detailed.

f. **Written notice** shall be defined as notice in writing delivered in person to the contractor, or to a partner of the firm in the case of a partnership, or to a member of the contracting organization, or to an officer of the organization in the case of a corporation, or sent to the last known business address of the contracting organization by registered mail.

g. **Work**, as used herein as a noun, is intended to include materials, labor, and workmanship of the appropriate contractor as supervised by the CM.

h. The **project** is the total construction work to be performed under the contract documents.

i. **Construction Management Fee** shall be an all inclusive lump sum management fee which will include all Construction Manager-at-Risk home office, project site and project related costs including all Construction Manager-at-Risk overhead costs and profit.

j. **Change order**, as used herein, shall mean a written order to the CM subsequent to the signing of the contract authorizing a change in the GMP contract. The change order shall be signed by the CM, designer and the Owner, and approved by the State Construction Office, in that order (Article 19).

k. **Field Order,** as used herein, shall mean a written approval for the CM to proceed with the work requested by Owner prior to issuance of a formal Change Order. The field order shall be signed by the CM, designer, Owner, and State Construction Office (SCO).

l. **Field Change,** as used herein shall mean a written approval from the Owner for the CM to proceed with work requested by the Owner to be paid for from the CM Contingency or Owner's Project Reserve within the GMP.

m. **Time of Completion**, as stated in the contract documents, is to be interpreted as consecutive calendar days measured from the date established in the written Notice to Proceed, or such other date as may be established herein (Article 23).

n. **Liquidated damages,** as stated in the contract documents, is an amount reasonably estimated in advance to cover the consequential damages associated with the Owner's economic loss in not being able to use the Project for its intended purposes at the end of the contract's completion date as amended by change order, if any, by reason of failure of the CM to complete the work within the time specified. Liquidated damages does not include the Owner's extended contract administration costs (including but not limited to additional fees for architectural and engineering services, testing services, inspection services, commissioning services, etc.), such other damages directly resulting from delays caused solely by the CM, or consequential damages that the Owner identified in the bid documents that may be impacted by any delay caused solely by the CM (e.g., if a multi-phased project-subsequent phases, delays in start of other projects that are dependent on the completion of this Project, extension of leases and/or maintenance agreements for other facilities).

o. **Surety**, as used herein, shall mean the bonding company or corporate body which is bound with and for the CM, and which engages to be responsible for the CM and his acceptable performance of the work.

p. **Routine written communications between the Designer and the Construction Manager** are any communication other than a "request for information" provided in letter, memo, or transmittal format, sent by mail, courier, electronic mail, or facsimile. Such communications cannot be identified as "request for information".

q. **Clarification or Request for information (RFI)** is a request from the CM seeking an interpretation or clarification by the Designer relative to the contract documents. The RFI, which shall be labeled (RFI), shall clearly and concisely set forth the issue or item requiring clarification or interpretation and why the response is needed. The RFI must set forth the CM's interpretation or understanding of the contract documents requirements in question, along with reasons for such an understanding.

r. **Approval** means written or imprinted acknowledgement that materials, equipment or methods of construction are acceptable for use in the work**.**

s. Inspection shall mean examination or observation of work completed or in progress to determine its compliance with contract documents.

t. **"Equal to" or "approved equal"** shall mean materials, products, equipment, assemblies, or installation methods considered equal by the bidder in all characteristics (physical, functional, and aesthetic) to those specified in the contract documents. Acceptance of equal is subject to approval of the designer and owner.

u. **"Substitution" or "substitute"** shall mean materials, products, equipment, assemblies, or installation methods deviating in at least one characteristic (physical, functional, or aesthetic) from those specified, but which in the opinion of the bidder would improve competition and/or enhance the finished installation. Acceptance of substitution is subject to the approval of the designer and owner.

v. **Provide** shall mean furnish and install complete in place, new, clean, operational, and ready for use.

w. **Indicated and shown** shall mean provide as detailed, or called for, and reasonably implied in the contract documents.

x. **Special inspector** is one who inspects materials, installation, fabrication, erection or placement of components and connections requiring special expertise to ensure compliance with the approved construction documents and referenced standards.

y. **Commissioning** is a quality assurance process that verifies and documents that building components and systems operate in accordance to the owner's project requirements and the project design documents.

z. **Designer Final Inspection** is the inspection performed by the design team to determine the completeness of the project in accordance with approved plans and specifications. This inspection occurs prior to SCO final inspection.

aa. **SCO Final Inspection** is the inspection performed by the State Construction Office to determine the completeness of the project in accordance with NC Building Codes and approved plans and specifications.

bb. **Beneficial Occupancy** is requested by the owner and is occupancy or partial occupancy of the building after all life safety items have been completed as determined by the State Construction Office. Life safety items include but not limited to fire alarm, sprinkler, egress and exit lighting, fire rated walls, egress paths and security.

cc. **Final Acceptance** is the date in which the State Construction Office accepts the construction as totally complete. This includes the SCO Final Inspection and certification by the designer that all punch lists are completed.

ARTICLE 2 - INTENT AND EXECUTION OF DOCUMENTS

a. The drawings and specifications are complementary, one to the other. That which is shown on the drawings or called for in the specifications shall be as binding as if it were both called for and shown. The intent of the drawings and specifications is to establish the scope of all labor, materials, transportation, equipment, and any and all other things necessary to provide a complete job. In case of discrepancy or disagreement in the contract documents, the order of precedence shall be: Form of Contract, specifications, large-scale detail drawings, small-scale drawings.

b. The wording of the specifications shall be interpreted in accordance with common usage of the language except that words having a commonly used technical or trade meaning shall be so interpreted in preference to other meanings.

c. The CM shall execute each copy of the response to RFP, contract, performance bond and payment bond as follows:

1. If the documents are executed by a sole Owner, that fact shall be evidenced by the word "Owner" appearing after the name of the person executing them.

2. If the documents are executed by a partnership, that fact shall be evidenced by the word "Co-Partner" appearing after the name of the partner executing them.

3. If the documents are executed on the part of a corporation, they shall be executed by either the president or the vice president and attested by the secretary or assistant secretary in either case, and the title of the office of such persons shall appear after their signatures. The seal of the corporation shall be impressed on each signature page of the documents.

4. If the documents are made by a joint venture, they shall be executed by each member of the joint venture in the above form for sole Owner, partnership or corporation, whichever form is applicable to each particular member.

5. All signatures shall be properly witnessed.

6. If the construction manager's license is held by a person other than an Owner, partner or officer of a firm, then the licensee shall also sign and be a party to the contract. The title "Licensee" shall appear under his/her signature.

7. The bonds shall be executed by an attorney-in-fact. There shall be attached to each copy of the bond a certified copy of power of attorney properly executed and dated.

8. Each copy of the bonds shall be countersigned by an authorized individual agent of the bonding company licensed to do business in North Carolina. The title "Licensed Resident Agent" shall appear after the signature.

9. The seal of the bonding company shall be impressed on each signature page of the bonds.

10. The CM's signature on the performance bond and the payment bond shall correspond with that on the contract.

ARTICLE 3 - CLARIFICATIONS AND DETAIL DRAWINGS

a. In such cases where the nature of the work requires clarification by the designer, such clarification shall be furnished by the designer with reasonable promptness by means of written instructions or detail drawings, or both. Clarifications and drawings shall be consistent with the intent of contract documents, and shall become a part thereof.

b. The CM and the Designer shall prepare, if deemed necessary, a schedule fixing dates upon which foreseeable clarifications will be required. The schedule will be subject to addition or change in accordance with progress of the work. The Designer shall furnish drawings or clarifications in accordance with that schedule. The CM shall not proceed with the work without such detail drawings and/or written clarifications.

ARTICLE 4 - COPIES OF DRAWINGS AND SPECIFICATIONS

The Designer or owner shall furnish free of charge to the CM electronic copies of plans and specifications. If requested by the CM, up to 30 paper copies of plans and specifications will be

provide free of charge,, plus a clean set of black line prints on white paper of all appropriate drawings, upon which the CM shall clearly and legibly record all work-in-place that is at variance with the contract documents. Additional sets shall be furnished at cost, including mailing, to the CM at the request of the CM.

ARTICLE 5 - SHOP DRAWINGS, SUBMITTALS, SAMPLES, DATA

a. Within fifteen (15) consecutive calendar days of the notice to proceed, a schedule for anticipated submission of all shop drawings, product data, samples, and similar submittals shall be prepared by the CM and provided to the designer. This schedule shall indicate the items, relevant specification sections, other related submittal data, and the date when these items will be furnished to the designer.

b. The CM shall review, approve and submit to the Designer all Shop Drawings, Coordination Drawings, Product Data, Samples, Color Charts, and similar submittal data required or reasonably implied by the Contract Documents. Required Submittals shall bear the CM's stamp of approval, any exceptions to the Contract Documents shall be noted on the submittals, and copies of all submittals shall be of sufficient quantity for the Designer to retain up to three (3) copies of each submittal for his own use plus additional copies as may be required by the CM. Submittals shall be presented to the Designer in accordance with the schedule submitted in paragraph (a). so as to cause no delay in the activities of the Owner.

c. The Designer shall review required submittals promptly, noting desired corrections if any, and retaining three (3) copies (1 for the Designer, 1 for the owner and 1 for SCO) for his use. The remaining copies of each submittal shall be returned to the CM not later than twenty (20) days from the date of receipt by the Designer, for the CM's use or for corrections and resubmittal as noted by the Designer. When resubmittals are required, the submittal procedure shall be the same as for the original submittal***s.***

d. Approval of shop drawings by the designer shall not be construed as relieving the CM from responsibility for compliance with the design or terms of the contract documents nor from responsibility of errors of any sort in the shop drawings, unless such error has been called to the attention of the designer in writing by the CM.

ARTICLE 6 - WORKING DRAWINGS AND SPECIFICATIONS AT THE JOB SITE

a. The CM shall maintain, in readable condition at his job office, one complete set of working drawings and specifications for his work including all shop drawings. Such drawings and specifications shall be available for use by the Designer or his authorized representative, owner or State Construction Office.

b. The CM shall maintain at the job office, a day-to-day record of work-in-place that is at variance with the contract documents. Such variations shall be fully noted on project drawings by the CM and submitted to the designer upon project completion and no later than thirty (30) days after acceptance of the project.

c. The contractor shall maintain at the job office a record of all required tests that have been performed, clearly indicating the scope of work inspected and the date of approval or rejection.

ARTICLE 7 - OWNERSHIP OF DRAWINGS AND SPECIFICATIONS

All drawings and specifications are instruments of service and remain the property of the Owner. The use of these instruments on work other than this contract without permission of the Owner is prohibited. All copies of drawings and specifications other than contract copies shall be returned to the Owner upon request after completion of the work.

ARTICLE 8 - MATERIALS, EQUIPMENT, EMPLOYEES

a. The CM shall, unless otherwise specified, supply & pay for all lighting, power, heat, sanitary facilities & water and shall require the Principal Trade and Specialty Contractors to, supply and pay for all labor, transportation, materials, tools, apparatus, scaffolding and incidentals necessary for the completion of his work, and to install, maintain and remove all equipment of the construction, other utensils or things, and be responsible for the safe, proper and lawful construction, maintenance and use of same. The CM shall construct in the best and most workmanlike manner, a complete job and everything incidental thereto, as shown on the plans, stated in the specifications, or reasonably implied there from, all in accordance with the contract documents.

b. All materials shall be new and of quality specified, except where reclaimed material is authorized herein and approved for use. Workmanship shall at all times be of a grade accepted as the best practice of the particular trade involved, and as stipulated in written standards of recognized organizations or institutes of the respective trades except as exceeded or qualified by the specifications.

c. Upon notice, the CM shall furnish evidence from the the Principal Trade and Specialty Contractors as to quality of materials.

d. Products are generally specified by ASTM or other reference standard and/or by manufacturer's name and model number or trade name. When specified only by reference standard, the CM through the Principal Trade or Specialty Contractor may select any product meeting this standard, by any manufacturer. When several products or manufacturers are specified as being equally acceptable, the CM through the Principal Trade or Specialty Contractor has the option of using any product and manufacturer combination listed. However, the CM through the Principal Trade or Specialty Contractor shall be aware that the cited examples are used only to denote the quality standard of product desired and that they do not restrict bidders to a specific brand, make, manufacturer or specific name; that they are used only to set forth and convey to bidders the general style, type, character and quality of product desired; and that equivalent products will be acceptable. The CM shall be responsible for reviewing all substitution requests from Principal Trade or Specialty Contractors prior to submission to the Project Designer and Owner and shall track & monitor all such requests. Requests for substitution of materials, items, or equipment shall be submitted to the Project Designer for approval or disapproval; such approval or disapproval shall be made by the designer prior to the opening of bids. Alternate materials may be requested after award if it can clearly be demonstrated that it is an added benefit to the owner and the designer and the owner approves.

e. The CM shall obtain written approval from the designer for the use of products, materials**,** equipment**,** assemblies or installation methods claimed as equal to those specified. Such approvals must be obtained as soon after contract awards as possible and before any materials are ordered.

f. The Designer is the judge of equality for proposed substitution of products, materials or equipment.

g. If at any time during the construction and completion of the work covered by these contract documents, the conduct of any workman of the various crafts be adjudged a nuisance to the Owner or Designer, or if any workman be considered detrimental to the work, the CM shall order such parties removed immediately from grounds.

ARTICLE 9 - ROYALTIES, LICENSES AND PATENTS

It is the intention of the contract documents that the work covered herein will not constitute in any way infringement of any patent whatsoever unless the fact of such patent is clearly evidenced herein. The CM shall protect and save harmless the Owner against suit on account of alleged or actual infringement. The CM shall pay all royalties and/or license fees required on account of patented articles or processes, whether the patent rights are evidenced hereinafter.

ARTICLE 10 - PERMITS, INSPECTIONS, FEES, REGULATIONS

a. The CM shall give all notices and comply with all laws, ordinances, codes, rules and regulations bearing on the conduct of the work under this contract. If the CM observes that the drawings and specifications are at variance therewith, he shall promptly notify the Designer in writing. Any necessary changes required after contract award shall be made by change order in accordance with Article 19. If the CM performs any work or authorizes any work to be performed knowing it to be contrary to such laws, ordinances, codes, rules and regulations, and without such notice to the designer, he shall bear all cost arising there from. Additional requirements implemented after bidding will be subject to equitable negotiations.

b. All work under this contract shall conform to the North Carolina State Building Code and other State, local and national codes as are applicable. The cost of all required inspections and permits shall be the responsibility of the CM unless otherwise specified.

c. Projects constructed by the State of North Carolina or by any agency or institution of the State are not subject to inspection by any county or municipal authorities and are not subject to county or municipal building codes. The CM shall, however, cooperate with the county or municipal authorities by obtaining building permits. Permits shall be obtained at no cost.

d. Projects involving local funding (Community Colleges) are also subject to county and municipal building codes and inspection by local authorities. The CM shall pay the cost of these permits and inspections unless otherwise specified.

ARTICLE 11 - PROTECTION OF WORK, PROPERTY AND THE PUBLIC

a. The CM shall be responsible for the entire site and the building or construction of the same and provide all the necessary protections, as required by the Owner or designer, and by laws or ordinances governing such conditions. The CM shall be responsible for any damage to the Owner's property or of that of others on the job, by them, their personnel, or their subcontractors, and shall make good such damages. The CM shall be responsible for and pay for any damages caused to the Owner. The CM shall have access to the project at all times.

b. The CM shall be responsible to cover and protect all portions of the structure when the work is not in progress, provide and set all temporary roofs, covers for doorways, sash and windows, and all other materials necessary to protect all the work on the building. Any work damaged through the lack of proper protection or from any other cause, shall be repaired or replaced without extra cost to the Owner.

c. No fires of any kind will be allowed inside or around the operations during the course of construction without special permission from the Designer.

d. The CM shall ensure that all trees and shrubs designated to remain in the vicinity of the construction operations are protected in accordance with the requirements of the plans and specifications. All walks, roads, etc., shall be barricaded as directed by the designer to keep the public away from the construction. All trenches, excavations or other hazards in the vicinity of the work shall be well barricaded and properly lighted at night.

e. The CM shall develop and implement a project safety plan that provides all necessary safety measures for the protection of all persons on the job, including the requirements of the A.G.C. *Accident Prevention Manual in Construction*, as amended, and shall fully comply with all state laws or regulations and North Carolina State Building Code requirements to prevent accident or injury to persons on or about the location of the work. The CM shall clearly mark or post signs warning of hazards existing, and shall barricade excavations, elevator shafts, stairwells and similar hazards. The CM shall insure that protection is provided against damage or injury resulting from falling materials and that all protective devices and signs be maintained throughout the progress of the work.

f. The CM shall adhere to the rules, regulations and interpretations of the North Carolina Department of Labor relating to Occupational Safety and Health Standards for the Construction Industry (Title 29, Code of Federal Regulations, Part 1926, published in Volume 39, Number 122, Part II, June 24, 1974, *Federal Register*), and revisions thereto as adopted by N.C.G.S. 95-126 through 155.

g. The CM shall. designate a responsible person of his organization as safety officer/inspector to inspect the project site for unsafe health and safety hazards, to report these hazards to the contractor for correction, and whose duties also include accident prevention on the project, and to provide other safety and health measures on the project site as required by the terms and conditions of the contract. The name of the safety inspector shall be made known to the designer and owner at the time of the preconstruction conference and in all cases prior to any work starting on the project.

h. In the event of an emergency affecting the safety of life, the protection of work, or the safety of adjoining properties, the CM is hereby authorized to act at his own discretion, without further authorization from anyone, to prevent such threatened injury or damage. Any compensation claimed by the CM on account of such action shall be determined as provided for under Article 19(b).

i. Any and all costs associated with correcting damage caused to adjacent properties of the construction site or staging area shall be borne by the contractor. These costs shall include but not be limited to flooding, mud, sand, stone, debris, and discharging of waste products.

ARTICLE 12 - SEDIMENTATION POLLUTION CONTROL ACT OF 1973

a. Any land-disturbing activity performed by the CM or any Principal Trade or Specialty Contractor in connection with the project shall comply with all erosion control measures set

forth in the contract documents and any additional measures which may be required in order to ensure that the project is in full compliance with the Sedimentation Pollution Control Act of 1973, as implemented by Title 15, North Carolina Administrative Code, Chapter 4, Sedimentation Control, Subchapters 4A, 4B and 4C, as amended (15 N.C.A.C. 4A, 4B and 4C).

b. Upon receipt of notice that a land-disturbing activity is in violation of said act, the CM shall be responsible for ensuring that all steps or actions necessary to bring the project in compliance with said act are promptly taken.

c. The CM shall be responsible for defending any legal actions instituted pursuant to N.C.G.S. 113A-64 against any party or persons described in this article.

d. To the fullest extent permitted by law, the CM shall indemnify and hold harmless the Owner, the designer and the agents, consultants and employees of the Owner and designer, from and against all claims, damages, civil penalties, losses and expenses, including, but not limited to, attorneys' fees, arising out of or resulting from the performance of work or failure of performance of work, provided that any such claim, damage, civil penalty, loss or expense is attributable to a violation of the Sedimentation Pollution Control Act. Such obligation shall not be construed to negate, abridge or otherwise reduced any other right or obligation of indemnity which would otherwise exist as to any party or persons described in this article.

ARTICLE 13 - INSPECTION OF THE WORK

a. It is a condition of this contract that the work shall be subject to inspection during normal working hours by the designer, designated official representatives of the Owner, State Construction Office and those persons required by state law to test special work for official approval. The CM shall therefore provide safe access to the work at all times for such inspections.

b. All instructions to the CM will be made only by or through the designer or his designated project representative. Observations made by official representatives of the Owner shall be conveyed to the designer for review and coordination prior to issuance to the CM.

c. The CM shall perform quality control inspections on the work of Principal Trade and Specialty Contractors to guard the Owner against defects and deficiencies in the work and shall coordinate this activity with the on-site duties of the Project Designer. The CM shall advise the Project Designer of any apparent variation and/or deviation from the intent of the Contract Documents and shall take the necessary action to correct such variations and deviations.

d. All work shall be inspected by designer, special inspector and/or State Construction Office prior to being covered by the contractor. The CM shall give a minimum two weeks notice unless otherwise agreed to by all parties. If inspection fails, after the first re-inspection all costs associated with additional re-inspections shall be borne by the CM.

e. Where special inspection or testing is required by virtue of any state laws, instructions of the designer, specifications or codes, the CM shall give adequate notice to the Project Designer of the time set for such inspection or test, if the inspection or test will be conducted by a party other than the Project Designer. Such special tests or inspections will be made in the presence of the Project Designer, or his authorized representative, and it shall be the CM’s responsibility to serve ample notice of such tests.

f. All laboratory tests shall be paid by the Owner unless provided otherwise in the contract documents except the CM shall pay for laboratory tests to establish design mix for concrete and for additional tests to prove compliance with contract documents where materials have tested deficient except when the testing laboratory did not follow the appropriate ASTM testing procedures.

g. Should any work be covered up or concealed prior to inspection and approval by the Project Designer and/or (SCO) such work shall be uncovered or exposed for inspection, if so requested by the Project Designer or SCO in writing. Inspection of the work will be made promptly upon notice from the CM. All cost involved in uncovering, repairing, replacing, recovering and restoring to design condition, the work that has been covered or concealed will be paid by the CM.

ARTICLE 14 - CONSTRUCTION SUPERVISION AND SCHEDULE

a. On-site representatives of the CM shall manage the work of the Principal Trade and Specialty Contractors and coordinate the work with the activities of the Owner and Project Designer to complete the project with the Owner's objectives of cost, time and quality. Throughout the progress of the work, the CM shall maintain a competent and adequate full-time staff approved by the Owner and Project Designer. It is understood that the designated and approved on-site representative of the CM will remain on the job and in responsible charge as long as those persons remain employed by the CM unless otherwise requested or agreed to by the Owner. The CM shall establish an on-site organization with appropriate lines of authority to act on behalf of the CM. Instructions, directions or notices given to the designated on-site authority shall be as binding as if given to the CM. However, directions, instructions, and notices shall be confirmed in writing.

b. The CM shall examine and study the drawings and specifications and fully understand the project design, and shall provide constant and efficient supervision to the work. Should he discover any discrepancies of any sort in the drawings or specifications, he shall report them to the designer without delay. He will not be held responsible for discrepancies in the drawings and/or specifications, but shall be held responsible to report them should they become known to him.

c. The CM shall call and preside over monthly job site progress conferences. All Principal Trade and Specialty Contractors shall be represented at these job progress conferences by both home office and project personnel. The CM shall require attendance from other subcontractors and material suppliers who can contribute toward maintaining required job progress. It shall be the principal purpose of these meetings, or conferences, to effect coordination, cooperation and assistance in every practical way toward the end of maintaining progress of the project on schedule and to complete the project within the specified contract time. The CM shall be prepared to assess progress of the work and to recommend remedial measures for correction of progress as may be appropriate. The CM with assistance from the Designer shall be the coordinator of the conferences and shall preside as chairman. The CM shall turn over a copy of his daily reports to the Designer and Owner at the job site progress conference. Owner will determine daily report format.

d. The CM shall employ an engineer or a land surveyor licensed in the State of North Carolina to lay out the work and to establish a bench mark nearby in a location where same will not be disturbed and where direct instruments sights may be taken.

e. Prior to bidding, it shall be the responsibility of the CM to prepare an electronic and paper copy of a preliminary critical path method (CPM) schedule and submit such schedule to the Project Designer for his review and comment in sufficient time to allow revisions prior to inserting said schedule into the Principal Trade and Specialty Contractors' bid packages. After contract award but prior to thirty (30) days from the date of the notice to proceed, the CM shall obtain from the Principal Trade and Specialty Contractors their respective work activities and integrate them into a project construction schedule in CPM form. The resulting CPM schedule shall show all salient features of the work required for construction of the project from start to finish within the time allotted by the contract. The time in days between the CM's early completion date and the contractual completion date is project float time and shall be used as such by the CM unless amended by change order. The CM shall submit to the Project Designer an electronic and paper copy of the final CPM schedule after contracts are executed but within fifteen (15) days prior to the written notice to proceed. The Project Designer after reviewing and commenting on the project CPM schedule shall submit it to the Owner for approval. No application for payment will be processed until the project CPM schedule is approved by the Owner. No monthly application for payment will be processed without the submission of an electronic and paper copy of the CPM schedule attached.

f. The CPM schedule shall be a complete computer generated network analysis showing the complete sequence of construction activities, identifying the work of separate stages and other logically grouped activities, indicating early and late start and early and late finish dates, float duration and a complete logic. Monthly updates will show the estimated completion of each activity.

g. The CM shall distribute to the principal trade and specialty contractors the approved project CPM schedule and shall display same at the job site.

h. The CM shall maintain the project CPM schedule, making monthly adjustments, updates, corrections, etc., which are necessary to finish the project within the time allotted by the contract. In doing so, the CM shall keep the designer as well as all Principal Trade and Specialty Contractors fully informed as to all changes and updates to the schedule. The CM shall submit to the Project Designer a monthly report of the status of all work activities. The monthly status report shall show the actual work completed to date in comparison with the original amount of work scheduled. If the work is behind schedule, the CM must indicate in writing what measures are being taken to bring the work back on schedule and ensure that the contract completion date is not exceeded. If the work is greater than thirty (30) days behind schedule and no legitimate requests for time extensions are in process, then the CM shall prepare and submit to the Project Designer a recovery schedule for review and approval. Failure of the CM to abide by the directives in this paragraph will give the Owner cause to exercise the remedies set forth in Article 29 of the General Conditions and pursue any other legal remedies allowed it by law.

ARTICLE 15 – {NOT USED}

ARTICLE 16 - PRINCIPAL TRADE AND SPECIALTY CONTRACTS AND CONTRACTORS

a. Principal Trade and Specialty Contractors shall be pre-qualified by the CM. The prequalification criteria shall be determined by the Owner and CM to address quality, performance, the time specified in the bids for performance of the contract, the cost of construction oversight, time for completion, capacity to perform, and any other factors deemed appropriate by the Owner and/or CM. Basic qualification information from Principal Trade and Specialty Contractors shall be requested on the standard State of North Carolina

Prequalification Form approved by the State Building Commission. Only pre-qualified contractors are allowed to bid to and contract with the CM on a project.

b. All bids for Principal Trade and Specialty Contracts shall be publically advertised and shall be opened publically in a public venue, and once opened, shall be public records under N.C.G.S. 132. The CM shall award the contract to the lowest responsible, responsive bidder, taking into consideration quality, performance, the time specified in the bids for performance of the contract, the time for completion, compliance with N.C.G.S. 143-128.2, and other factors deemed appropriate by the Owner and advertised as part of the bid solicitation. When contracts are awarded pursuant to this section, the Owner shall provide for a dispute resolution procedure as provided by N.C.G.S. 143-128(f1). Once Principal Trade and Specialty Contractors are in place, the CM shall provide copies of the contracts to the Project Designer and also provide a list of equipment and material suppliers.

c. A CM may perform a portion of the work only if (a) bidding produces no responsible, responsive bidder for that portion of the work, or (b) the lowest responsible, responsive bidder will not execute a contract for the bid portion of the work, or the Principal Trade or Specialty Contractor defaults and a prequalified replacement cannot be obtained in a timely manner, and (c) the Owner approves performance of the work by the CM.

d. The Designer will furnish to any Principal Trade or Specialty Contractor, upon request, evidence regarding amounts of money paid to the CM on account of the work of the Principal Trade or Specialty Contractor.

e. The CM is and remains fully responsible for his own acts or omissions as well as those of any Principal Trade or Specialty Contractor or of any employee of either. The CM agrees that no contractual relationship exists between the Principal Trade and Specialty Contractors and the Owner in regard to the contract, and that the Principal Trade and Specialty Contractors act on this work as an agent or employee of the CM.

ARTICLE 17 - CONSTRUCTION MANAGER AND SUBCONTRACTOR RELATIONSHIPS

The CM agrees that the terms of these contract documents shall apply equally to each Principal Trade and Specialty Contractor as to the CM, and the CM agrees to take such action as may be necessary to bind each Principal Trade and Specialty Contractor to these terms. The CM further agrees to conform to the Code of Ethical Conduct as adopted by the Associated General Contractors of America, Inc., with respect to CM-subcontractor relationships, and that payments to Principal Trade and Specialty Contractors shall be made in accordance with the provisions of N.C.G.S. 143-134.1 titled “Interest on final payments due to prime contractors: payments to subcontractors”.

a. On all public construction contracts which are let by a board or governing body of the state government or any political subdivision thereof, except contracts let by the Department of Transportation pursuant to N.C. G.S. 136-28.1, the balance due the CM shall be paid in full within 45 days after respective prime contracts of the project have been accepted by the Owner, certified by the architect, engineer or designer to be completed in accordance with terms of the plans and specifications, or occupied by the Owner and used for the purpose for which the project was constructed, whichever occurs first. Provided, however, that whenever the architect or consulting engineer in charge of the project determines that delay in completion of the project in accordance with terms of the plans and specifications is the fault of the CM, the project may be occupied and used for the purposes for which it was constructed without payment of any interest on amounts withheld past the 45 day limit. Should final

payment to the CM beyond the date such contracts have been certified to be completed by the Project Designer, accepted by the Owner, or occupied by the Owner and used for the purposes for which the project was constructed, be delayed by more than 45 days, said CM shall be paid interest, beginning on the 46th day, at the rate of one percent (1%) per month or fraction thereof unless a lower rate is agreed upon on such unpaid balance as may be due. In addition to the above final payment provisions, periodic payments due the CM during construction shall be paid in accordance with the payment provisions of the contract documents or said CM shall be paid interest on any such unpaid amount at the rate stipulated above for delayed final payments. Such interest shall begin on the date the payment is due and continue until the date on which payment is made. Such due date may be established by the terms of the contract. Funds for payment of such interest on state-owned projects shall be obtained from the current budget of the owning department, institution or agency. Where a conditional acceptance of a contract exists, and where the Owner is retaining a reasonable sum pending correction of such conditions, interest on such reasonable sum shall not apply.

b. Within seven days of receipt by the CM of each periodic or final payment, the CM shall pay the Principal Trade and Specialty Contractors based on work completed or service provided under their contract with the CM. Should any periodic or final payment to a Principal Trade or Specialty Contractor be delayed by more than seven days after receipt of periodic or final payment by the CM, the CM shall pay the Principal Trade or Specialty Contractor interest, beginning on the eighth day, at the rate of one percent (1%) per month or fraction thereof on such unpaid balance as may be due.

c. The percentage of retainage on payments made by the CM to the Principal Trade and Specialty Contractors shall not exceed the percentage of retainage on payments made by the Owner to the CM. Any percentage of retainage on payments made by the CM to the Principal Trade or Specialty Contractors that exceeds the percentage of retainage on payments made by the Owner to the CM shall be subject to interest to be paid by the CM to the Principal Trade or Specialty Contractor at the rate of one percent (1%) per month or fraction thereof.

d. Nothing in this section shall prevent the CM at the time of application and certification to the Owner from withholding application and certification to the Owner for payment to a Principal Trade or Specialty Contractor for unsatisfactory job progress; defective construction not remedied; disputed work; third-party claims filed or reasonable evidence that claim will be filed; failure of the Principal Trade or Specialty Contractor to make timely payments for labor, equipment and materials; damage to CM or another subcontractor; reasonable evidence that a Principal Trade or Specialty Contract cannot be completed for the unpaid balance of the subcontract sum; or a reasonable amount for retainage not to exceed the initial percentage retained by Owner.

ARTICLE 18 - DESIGNER'S STATUS

a. The Project Designer shall provide liaison and necessary inspection of the work to ensure compliance with plans and specifications. He is the agent of the Owner only for the purpose of constructing this work and to the extent stipulated in the contract documents. He has authority to stop work or to order work removed, or to order corrections of faulty work where such action may be necessary to assure successful completion of the work.

b. The Project Designer is the impartial interpreter of the contract documents, and, as such, he shall exercise his powers under the contract to enforce faithful performance by both the Owner and the CM, taking sides with neither.

c. Should the Project Designer cease to be employed on the work for any reason whatsoever, then the Owner shall employ a competent replacement who shall assume the status of the former Project Designer.

d. The Project Designer will make periodic inspections of the project at intervals appropriate to the stage of construction. He will inspect the progress, the quality and the quantity of the work.

e. The Project Designer and the Owner shall have access to the work whenever it is in preparation and progress during normal working hours. The CM shall provide facilities for such access so the Designer may perform his functions under the contract documents.

f. Based on the Project Designer's inspections and evaluations of the project, the Project Designer shall issue interpretations, directives and decisions as may be necessary to assist the CM in the administration of the project. His decisions relating to artistic effect and technical matters shall be final, provided such decisions are within the limitations of the contract. The CM's decisions, however, relating to means and methods, and administration of the contracts the CM holds are final.

ARTICLE 19 - CHANGES IN THE WORK

a. The Owner may have changes made in the work covered by the contract. These changes will not invalidate and will not relieve or release the CM from any guarantee given by him pertinent to the contract provisions. These changes will not affect the validity of the guarantee bond and will not relieve the surety or sureties of said bond. All extra work shall be executed under conditions of the original contract.

b. Except in an emergency endangering life or property, no change shall be made by the contractor except upon receipt of approved_change order or written field order from the designer, countersigned by the owner and the state construction office authorizing such change. No claim for adjustments of the contract price shall be valid unless this procedure is followed.

A field order, transmitted by fax or hand- delivered, may be used where the change involved impacts the critical path_of the work. A formal change order shall be issued as expeditiously as possible.

The CM may be requested to make a change to the work by the Project Designer and Owner where such work is to be funded by the CM Contingency or Project Reserve that is part of the GMP contract. Such a change must be documented in the same manner as a Change Order and must be authorized in writing by the Project Designer and Owner by a Field Change document.

In the event of emergency endangering life or property, the CM may be directed to proceed on a time and material basis whereupon the CM shall proceed and keep accurately on such form as may be required, a correct account of costs together with all proper invoices, payrolls and supporting data. Upon completion of the work the change order will be prepared as outlined under either Method "c(1)" or Method "c(2)" or both.

c. In determining the values of changes, either additive or deductive, the CM and Principal Trade and Specialty Contractors are restricted to the use of the following methods:

1. Where the extra work involved is covered by unit prices quoted in the proposal, the value of the change shall be computed by application of unit prices based on quantities,

estimated or actual as agreed of the items involved, except is such cases where a quantity exceeds the estimated quantity allowance in the contract by one hundred percent (100%) or more. In such cases, either party may elect to proceed under subparagraph c2 herein. If neither party elects to proceed under c2, then unit prices shall apply.

2. The contracting parties shall negotiate and agree upon the equitable value of the change prior to issuance of the change order, and the change order shall stipulate the corresponding lump sum adjustment to the contract price.

d. Under Paragraph "b" and Methods "c(2)" above, the allowances for overhead and profit combined for a Principal Trade or Specialty Contractor and all multi-tier subcontractors shall not exceed fifteen percent (15%) of **net cost** of the work. No allowance for overhead and profit will be allowed for the CM until the change orders aggregate to a sum in excess of five percent (5%) of the Cost of the Work portion of the GMP. Once this threshold is met the CM may add an overhead & profit allowance not to exceed four percent (4%) of the net cost of the change order. Change orders to the GMP which authorize additional phases of a project without a change in scope of the originally intended project will not be considered in establishing the threshold for additional CM overhead & profit. Under Method "c (1)", no additional allowances shall be made for overhead and profit. In the case of deductible change orders, under Method "c(2)" and Paragraph (b) above, the contractor shall include no less than five percent (5%***)*** profit, but no allowances for overhead.

e. The term "net cost" as used herein shall mean the difference between all proper cost additions and deductions. The "cost" as used herein shall be limited to the following:

1. The actual costs of materials and supplies incorporated or consumed as part of the project;

2. The actual costs of labor expended on the project site;

3. The actual costs of labor burden, limited to the costs of social security (FICA) and Medicare/Medicaid taxes; unemployment insurance costs; health/dental/vision insurance premiums; paid employee leave for holidays, vacation, sick leave, and/or petty leave, not to exceed a total of 30 days per year; retirement contributions; worker's compensation insurance premiums; and the costs of general liability insurance when premiums are computed based on payroll amounts; the total of which shall not exceed thirty percent (30%) of the actual costs of labor;

4. The actual costs of rental for tools, excluding hand tools; equipment; machinery; and temporary facilities required for the project;

5. The actual costs of premiums for bonds, insurance, permit fees and sales or use taxes related to the project.

Overtime and extra pay for holidays and weekends may be a cost item only to the extent approved by the Owner.

f. Should concealed conditions be encountered in the performance of the work below grade, or should concealed or unknown conditions in an existing structure be at variance with the conditions indicated by the contract documents, the contract sum and time for completion may be equitably adjusted by change order upon claim by either party made within thirty (30) days after the condition has been identified. The cost of such change shall be arrived at by one of the foregoing methods.

All change orders shall be supported by a breakdown showing method of arriving at net cost as defined above.

g. In all change orders, the procedure will be for the Project Designer to request proposals for the change order work in writing. The CM will require the Principal Trade and Specialty Contractors to provide such proposals and supporting data in suitable format and will review and approve such change orders prior to submission to the designer. The Project Designer shall verify correctness. Within fourteen (14) days after receipt of the CM's proposal**,** the Project Designer shall prepare the change order and forward to the CM for his signature or otherwise respond, in writing, to the CM's proposal. Within seven (7) days after receipt of the change order executed by the CM, the Project Designer shall, certify the change order by his signature, and forward the change order and all supporting data to the Owner for the Owner's signature. The Owner shall execute the change order and forward to the State Construction Office for final approval**,** within seven (7) days of receipt. The State Construction Office shall act on the change order within seven (7) days. Upon approval by the State Construction Office, one copy remains with the State Construction Office, and the remaining copies are sent to the Project Designer for distribution to the Owner(s)**,** CM and the surety. In case of emergency or extenuating circumstances, approval of changes may be obtained verbally by telephone or field orders approved by all parties, then shall be substantiated in writing as outlined under normal procedure.

h. At the time of signing a change order, the CM shall be required to certify as follows:

"I certify that my bonding company will be notified forthwith that my contract has been changed by the amount of this change order, and that a copy of the approved change order will be mailed upon receipt by me to my surety."

i. A change order, when issued, shall be full compensation, or credit, for the work included, omitted or substituted. It shall show on its face the adjustment in time for completion of the project as a result of the change in the work.

j. If, during the progress of the work, the Owner requests a change order and the CM's terms are unacceptable, the Owner**,** with the approval of the State Construction Office, may require the CM to perform such work on a time and material basis in accordance with paragraph "b" above. Without prejudice, nothing in this paragraph shall preclude the Owner from performing or to have performed that portion of the work requested in the change order.

ARTICLE 20 - CLAIMS FOR EXTRA COST

a. Should the CM consider that as a result of any instructions given in any form by the designer, he is entitled to extra cost above that stated in the contract, he shall give written notice thereof to the designer within seven (7) days without delay. The written notice shall clearly state that a claim for extra cost is being made and shall provide a detailed justification for the extra cost. The CM shall not proceed with the work affected until further advised, except in emergency involving the safety of life or property, which condition is covered in Article 19(b) and Article 11(h). No claims for extra compensation will be considered unless the claim is so made. The Designer shall render a written decision within seven (7) days of receipt of claim.

b. The CM shall not act on instructions received by him from persons other than the Project Designer, and any claims for extra compensation or extension of time on account of such instruction will not be honored. The Project Designer will not be responsible for misunderstandings claimed by the CM of verbal instructions which have not been confirmed in writing, and in no case shall instructions be interpreted as permitting a departure from the

contract documents unless such instruction is confirmed in writing and supported by a properly authorized change order.

c. Should a claim for extra compensation that complies with the requirements of (a) above by the CM be denied by the Project Designer or Owner, and cannot be resolved by a representative of the State Construction Office, the CM may request a mediation in connection with N.C.G.S. 143-128(f1) in the dispute resolution rules adopted by the State Building Commission (1 N.C.A.C. 30H .0101 through .1001). If the CM is unable to resolve its claims as a result of mediation, then the CM may pursue his claim in accordance with the provisions of N.C.G.S. 143-135.3, or G.S. 143-135.6 where Community Colleges are the owner, and the following:

1. A CM who has not completed a contract with a state agency or institution for construction or repair work and who has not received the amount he claims is due under the contract may submit a verified written claim to the Director of the State Construction Office of the Department of Administration for the amount the CM claims is due. The Director may deny, allow or compromise the claim, in whole or in part. A claim under this subsection is not a contested case under N.C.G.S. Chapter 150B.

2. (a) A CM who has completed a contract with a State agency or institution for construction or repair work and who has not received the amount he claims is due under the contract may submit a verified written claim to the Director of the State Construction Office of the Department of Administration for the amount the CM claims is due. The claim shall be submitted within sixty (60) days after the CM receives a final statement of the board's disposition of his claim and shall state the factual basis for the claim.

(b) The Director shall investigate a submitted claim within ninety (90) days of receiving the claim, or within any longer time period upon which the Director and the CM agree. The CM may appear before the Director, either in person or through counsel, to present facts and arguments in support of his claim. The Director may allow, deny or compromise the claim, in whole or in part. The Director shall give the CM a written statement of the Director's decision on the CM’s claim.

(c) A CM who is dissatisfied with the Director's decision on a claim submitted under this subsection may commence a contested case on the claim under Chapter 150B of the General Statutes. The contested case shall be commenced within sixty (60) days of receiving the Director's written statement of the decision.

(d) As to any portion of a claim that is denied by the Director, the CM may, in lieu of the procedures set forth in the preceding subsection of this section, within six (6) months of receipt of the Director's final decision, institute a civil action for the sum he claims to be entitled to under the contract by filing a verified complaint and the issuance of a summons in the Superior Court of Wake County or in the superior court of any county where the work under the contract was performed. The procedure shall be the same as in all civil actions except that all issues shall be tried by the judge, without a jury.

ARTICLE 21 - MINOR CHANGES IN THE WORK

The Project Designer will have the authority to order minor changes in the work not involving an adjustment in the contract sum or time for completion, and not inconsistent with the intent of the contract documents. Such changes shall be effected by written order, copied to the State Construction Office, and shall be binding on the Owner and the CM.

ARTICLE 22 - UNCORRECTED FAULTY WORK

Should the correction of faulty or damaged work be considered inadvisable or inexpedient by the Owner and the Project Designer, the Owner shall be reimbursed by the CM. A change order will be issued to reflect a reduction in the contract sum.

ARTICLE 23 - TIME OF COMPLETION, DELAYS, EXTENSION OF TIME

a. The final completion date will be as determined by the Owner, Designer and CM during the pre-construction phase of the project and will be incorporated into the contract for construction services between the Owner and the CM.

b. The CM shall commence work to be performed under this agreement on a date to be specified in a written Notice to Proceed from the Project Designer and shall fully complete all work hereunder within the time of completion specified. For each day in excess of the above number of days, the CM shall pay the Owner the sum stated as liquidated damages reasonably estimated in advance to cover the loses to be incurred by the Owner by reason of failure of the CM to complete the work within the time specified, such time being in the essence of this contract and a material consideration thereof. Should the work be delayed by both the owner and contractor, liquidated damages shall be apportioned to reflect the delays of each party. In the case of concurrent delays, contractor caused delays shall be accounted for before owner and designer caused delays.

c. If the CM is delayed at any time in the progress of his work by any act or negligence of the Owner or the Project Designer, or by any employee of either; by changes ordered in the work; by labor disputes at the project site; by abnormal weather conditions not reasonably anticipated for the locality where the work is performed; by unavoidable casualties; by any causes beyond the contractor's control; or by any other causes which the designer and Owner determine may justify the delay, then the contract time may be extended by change order for the time which the designer and Owner may determine is reasonable.

   Time extensions will not be granted for rain, wind, snow or other natural phenomena of normal intensity for the locality where work is performed. For purpose of determining extent of delay attributable to unusual weather phenomena, a determination shall be made by comparing the weather for the contract period involved with the average of the preceding five (5) year climatic range during the same time interval based on the National Oceanic and Atmospheric Administration National Weather Service statistics for the locality where work is performed and on daily weather logs kept on the job site by the CM reflecting the effect of the weather on progress of the work and initialed by the designer's representative. No weather delays shall be considered after the building is dried in unless work claimed to be delayed is on the critical path of the baseline schedule or approved updated schedule. Time extensions for weather delays, acts of God, labor disputes, fire, delays in transportation, unavoidable casualties or other delays which are beyond the control of the Owner do not entitle the Contractor to compensable damages for delays. Any contractor claim for compensable damages for delays is limited to delays caused solely by the owner or its agents. Contractor caused delays shall be accounted for before owner or designer caused delays in the case of concurrent delays.

d. Request for extension of time shall be made in writing to the designer, copies to the owner and SCO, within twenty (20) days following cause of delay. In case of continuing cause for delay, the CM shall notify the designer copies to the owner and SCO, of the delay within twenty (20) days of the beginning of the delay and only one claim is necessary.

e. The CM shall notify his surety in writing of extension of time granted.

f. No claim shall be allowed on account of failure of the Project Designer to furnish drawings or instructions until twenty (20) days after demand for such drawings and/or instructions. See Article 5c. Demand must be in written form clearly stating the potential for delay unless the drawings or instructions are provided. Any delay granted will begin after the twenty (20) day demand period is concluded.

ARTICLE 24 - PARTIAL UTILIZATION/BENEFICIAL OCCUPANCY

a. The Owner may desire to occupy or utilize all or a portion of the project when the work is substantially complete.

b. Should the owner request a utilization of a building or portion thereof, the designer shall perform a designer final inspection of area after being notified by the contractor that the area is ready for such. After the contractor has completed designer final inspection punch list and the designer has verified, then the designer shall schedule a beneficial occupancy inspection at a time and date acceptable to the owner, contractor(s) and State Construction Office. If beneficial occupancy is granted by the State Construction Office, in such areas the following will be established:

1. The beginning of guarantees and warranties period for the equipment necessary to support. in the area.

2. The owner assumes all responsibiliites for utility costs for entire building.

3. Contractor will obtain consent of surety.

4. Contractor will obtain endorsement from insurance company permitting beneficial occupancy.

c. The Owner shall have the right to exclude the CM from any part of the project which the Project Designer has so certified to be substantially complete, but the Owner will allow the CM reasonable access to complete or correct work to bring it into compliance with the contract.

d. Occupancy by the Owner under this article will in no way relieve the CM from his contractual requirement to complete the project within the specified time. The contractor will not be relieved of liquidated damages because of beneficial occupancy. The designer may prorate liquidated damages based on the percentage of project occupied.

ARTICLE 25 - FINAL INSPECTION, ACCEPTANCE, AND PROJECT CLOSEOUT

a. Upon notification from the CM that the project is complete and ready for inspection, the Project Designer shall make a designer final inspection to verify that the project is complete and ready for SCO final inspection. Prior to SCO final inspection, the CM shall ensure that all items requiring corrective measures noted at the designer final inspection are complete.

The Project Designer shall schedule an SCO final inspection at a time and date acceptable to the Owner, the CM and the State Construction Office.

b. At the SCO final inspection, the designer and his consultants shall, if job conditions warrant, record a list of items that are found to be incomplete or not in accordance with the contract documents. At the conclusion of the SCO final inspection, the designer and State Construction Office representative shall make the following determinations:

   1. That the project is completed and accepted.

   2. That the project is accepted subject to the correction of the list of discrepancies (punch list). All punch list items must be completed within thirty (30) days of SCo final inspection or the Owner may invoke Article 28, Owner's Right to Do Work.

   3. That the project is not complete and another date for a final inspection will be established.

c. Within fourteen (14) days of acceptance per Paragraph c1 or within fourteen (14) days after completion of punch list per Paragraph c2 above, the Project Designer shall certify the work and issue applicable certificate(s) of compliance.

d. Any discrepancies listed or discovered after the date of SCO final inspection and acceptance under Paragraphs c1 or c2 above shall be handled in accordance with Article 42.

e. The date of acceptance will establish the following:

   1. The beginning of guarantees and warranties period.

   2. The date on which the CM's insurance coverage for public liability, property damage and builder's risk may be terminated.

   3. That no liquidated damages (if applicable) shall be assessed after this date.

   4. The termination date of utility cost to the CM (if applicable).

f. **Prior to issuance of final acceptance date, the contractor shall have his authorized representatives visit the project and give full instructions to the designated personnel regarding operating, maintenance, care, and adjustment of all equipment and special construction elements. In addition, the contractor shall provide to the owner a complete instructional video (media format acceptable to the owner) on the operation, maintenance, care and adjustment of all equipment and special construction elements.**

ARTICLE 26 - CORRECTION OF WORK BEFORE FINAL PAYMENT

a. Any work, materials, fabricated items or other parts of the work which have been condemned or declared not in accordance with the contract by the designer shall be promptly removed from the work site by the CM, and shall be immediately replaced by new work in accordance with the contract at no additional cost to the Owner. Work or property of the Owner, damaged or destroyed by virtue of such faulty work, shall be made good at the expense of the CM.

b. Correction of condemned work described above shall commence within twenty-four (24) hours after receipt of notice from the Project Designer, and shall make satisfactory progress until completed.

c. Should the CM fail to proceed with the required corrections, then the Owner may complete the work in accordance with the provisions of Article 28.

ARTICLE 27 - CORRECTION OF WORK AFTER FINAL PAYMENT

See Article 35, Performance Bond and Payment Bond, and Article 42, Guarantee**.** Neither the final certificate, final payment, occupancy of the premises by the Owner, nor any provision of the contract, nor any other act or instrument of the Owner, nor the Project Designer, shall relieve the CM from responsibility for negligence, or faulty material or workmanship, or failure to comply with the drawings and specifications. The CM shall correct or make good any defects due thereto and repair any damage resulting therefrom, which may appear during the guarantee period following final acceptance of the work except as stated otherwise under Article 42, Guarantee. The Owner will report any defects as they may appear to the CM and establish a time limit for completion of corrections by the CM. The Owner will be the judge as to the responsibility for correction of defects.

ARTICLE 28 - OWNER'S RIGHT TO DO WORK

If, during the progress of the work or during the period of guarantee, the CM fails to prosecute the work properly or to perform any provision of the contract, the Owner, after seven (7) days written notice sent by certified mail, return receipt requested, to the CM from the designer, may perform or have performed that portion of the work. The cost of the work may be deducted from any amounts due or to become due to the CM, such action and cost of same having been first approved by the Project Designer. Should the cost of such action of the Owner exceed the amount due or to become due the CM, then the CM or his surety, or both, shall be liable for and shall pay to the Owner the amount of said excess.

ARTICLE 29 - ANNULMENT OF CONTRACT

If the CM fails to begin the work under the contract within the time specified or fails to establish a GMP or obtain bids from or enter into contracts with qualified Principal Trade or Specialty Contractors within the GMP, or the progress of the work is not maintained on schedule, or the work is not completed within the time above specified, or fails to perform the work with sufficient workmen and equipment or with sufficient materials to ensure the prompt completion of said work, or shall perform the work unsuitably or shall discontinue the prosecution of the work, or if the CM shall become insolvent or be declared bankrupt or commit any act of bankruptcy or insolvency, or allow any final judgment to stand against him unsatisfied for a period of forty-eight (48) hours, or shall make an assignment for the benefit of creditors, or for any other cause whatsoever shall not carry on the work in an acceptable manner, the Owner may give notice in writing, sent by certified mail, return receipt requested, to the CM and his surety of such delay, neglect or default, specifying the same, and if the CM within a period of seven(7) days after such notice shall not proceed in accordance therewith, then the Owner shall, declare this contract in default, and, thereupon, the surety shall promptly take over the work and complete the performance of this contract in the manner and within the time frame specified. In the event the surety shall fail to take over the work to be done under this contract within seven(7) days after being so notified and notify the Owner in writing, sent by certified mail, return receipt requested, that he is taking the same over and stating that he will diligently pursue and complete the same, the Owner shall have full power and authority, without violating the contract, to take the prosecution of the work out of the hands of said CM, to appropriate or use any or all contract materials and equipment on the grounds as may be suitable and acceptable and may enter into an agreement, either by public letting or negotiation, for the completion of said contract according to the terms and provisions thereof or use such other methods as in his opinion shall be required for the completion of said contract in an acceptable manner. All costs and charges incurred by the Owner, together with the costs of completing the

work under contract, shall be deducted from any monies due or which may become due said CM and surety. In case the expense so incurred by the Owner shall be less than the sum which would have been payable under the contract, if it had been completed by said CM, then the said CM and surety shall be entitled to receive the difference, but in case such expense shall exceed the sum which would have been payable under the contract, then the CM and the surety shall be liable and shall pay to the Owner the amount of said excess.

ARTICLE 30 – CONSTRUCTION MANAGER'S RIGHT TO STOP WORK OR TERMINATE THE CONTRACT

a. Should the work be stopped by order of a court having jurisdiction, or by order of any other public authority for a period of three months, due to cause beyond the fault or control of the CM, or if the Owner should fail or refuse to make payment on account of a certificate issued by the designer within forty-five (45) days after receipt of same, then the CM, after fifteen (15) days' written notice sent by certified mail, return receipt requested, to the Owner and the designer, may suspend operations on the work or terminate the contract.

b. The Owner shall be liable to the CM for the cost of all materials delivered and work performed on this contract plus ten (10) percent overhead and profit and shall make such payment. The designer shall be the judge as to the correctness of such payment.

ARTICLE 31 - REQUEST FOR PAYMENT

a. Not later than the fifth day of the month, the CM shall submit to the designer a request for payment for work done during the previous month. The request shall be in the form agreed upon between the CM and the designer, but shall show substantially the value of work done and materials delivered to the site during the period since the last payment, and shall sum up the financial status of the contract with the following information:

    1. Total of contract including change orders.

    2. Value of work completed to date.

    3. Less five percent (5%) retainage, provided however, that after fifty percent (50%) of the CM's work has been satisfactorily completed on schedule, with approval of the owner and the State Construction Office and written consent of the surety, further requirements for retainage will be waived only so long as work continues to be completed satisfactorily and on schedule.

    4. Less previous payments.

    5. Current amount due.

b. Prior to submitting the first payment request, the CM shall prepare a schedule showing a breakdown of the contract price into values of the various parts of the GMP contract. The Cost of the Work breakdown will be arranged so as to facilitate payments to the Principal Trade and Specialty Contractors in accordance with Article 17. The combined CM Construction Management Fee, Bonds & Insurance, CM Contingency, and Project Reserve (if any) will be shown on the Schedule of values as separate lines. The values for the CM Contingency and Project Reserve (if any) will move to appropriate lines within the Cost of the Work as those funds are committed and expended. This schedule of values will be submitted to & approved by the designer and Owner within 30 days of the Notice to Proceed.

The schedule of values shall be prepared in such form and supported by such data to substantiate its accuracy as the designer and Owner may require.

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c. Applications for payment shall be in a form agreed upon by the CM, designer and Owner and shall prepared and supported by such data to substantiate the accuracy of the request as the designer may require.

d. Subject to other provisions of the contract documents, the amount of each progress payment shall be computed as follows:

   1. Take that portion of the GMP properly allocable to completed work as determined by multiplying the percentage completion of each portion Cost of the Work by the share of the GMP allocated to that portion of the work in the schedule of values.

   2. Add that portion of the GMP properly allocable to materials and equipment delivered and suitably stored at the site for subsequent incorporation in the work or if approved in advance by the Owner, suitably stored off site at a location agreed upon in writing.

   3. Subtract the aggregate of previous payments made by the Owner.

   4. Subtract the amount, in any, by which the CM has been previously overpaid, as evidenced by the Owner's review of the CM's documentation.

   5. Subtract amounts, if any, for which the Project Designer has withheld or nullified a certificate of payment.

   6. Subtract retainage as per paragraph (h) below.

   7. Add the amount due for the CM Construction Management Fee calculated on the basis the percentage completion of the project or on a schedule of payment negotiated with the Owner less fifteen percent (15%) and less previous payments for CM Construction Management Fee.

e. Payment allocated to Principal Trade and Specialty Contractors shall be subject to five percent (5%) retainage, provided, however that after fifty percent (50%) of the Cost of the Work has been satisfactorily completed on schedule, with the approval of the Owner and the State Construction Office and with written consent of the surety, further requirements for retainage will be waived only so long as work continues to be completed satisfactorily and on schedule. The balance of the CM Construction Management Fee shall be held by the Owner until satisfactory completion and close out of the project. Satisfactory completion and close out of the project means that the Owner and Project Designer are satisfied that the project has been completed in accordance with the plans and specifications and within the GMP, all general conditions of the contract pertaining to close out have been satisfied, and all Principal Trade and Specialty Contractors have satisfactorily completed their respective contracts. No retainage will be held for the cost of Bonds and Insurance

f. When payment is made on account of stored materials and equipment, such materials must be stored on the owner's property, and the requests for payments shall be accompanied by invoices or bills of sale or other evidence to establish the owner's title to such materials and equipment. Such payments will be made only for materials that have been customized or fabricated specifically for this project. Raw materials or commodity products including but not limited to piping, conduit, CMU, metal studs and gypsum board may not be submitted. Responsibility for such stored materials and equipment shall remain with the CM regardless

of ownership title. Such stored materials and equipment shall not be removed from the owner's property. Should the space for storage on-site be limited, the CM, at his option, shall be permitted to store such materials and/or equipment in a suitable space off-site. Should the CM desire to include any such materials or equipment in his application for payment, they must be stored in the name of the owner in an independent, licensed, bonded warehouse approved by the designer, owner and the State Construction Office and located as close to the site as possible. The warehouse selected must be approved by the CM's bonding and insurance companies; the material to be paid for shall be assigned to the owner and shall be inspected by the designer. Upon approval by the designer, owner and SCO of the storage facilities and materials and equipment, payment therefore will be certified. Responsibility for such stored materials and equipment shall remain with the CM. Such stored materials and equipment shall not be moved except for transportation to the project site. Under certain conditions, the designer may approve storage of materials at the point of manufacture, which conditions shall be approved by the designer, the owner and the State Construction Office prior to approval for the storage and shall include an agreement by the storing party which unconditionally gives the State absolute right to possession of the materials at anytime. Bond, security and insurance protection shall continue to be the responsibility of the CM.

g. In the event of beneficial occupancy, retainage of funds due the CM may be reduced with the approval of the State Construction Office to an equitable amount to cover the list of items to be completed or corrected. Retainage may not be reduced to less than two and one-half (2 1/2) times the estimated value of the work to be completed or corrected. Reduction of retainage must be with the consent and approval of the CM's bonding company.

ARTICLE 32 - CERTIFICATES OF PAYMENT AND FINAL PAYMENT

a. Within five (5) days from receipt of request for payment from the CM, the designer shall issue and forward to the Owner a certificate for payment. This certificate shall indicate the amount requested or as approved by the designer. If the certificate is not approved by the designer, he shall state in writing to the CM and the Owner his reasons for withholding payment.

b. No certificate issued or payment made shall constitute an acceptance of the work or any part thereof. The making and acceptance of final payment shall constitute a waiver of all claims by the Owner except:

   1. Claims arising from unsettled liens or claims against the CM.

   2. Faulty work or materials appearing after final payment.

   3. Failure of the contractor to perform the work in accordance with drawings and specifications, such failure appearing after payment.

   4. As conditioned in the performance bond and payment bond.

c. The making and acceptance of final payment shall constitute a waiver of all claims by the CM except those claims previously made and remaining unsettled (Article 20(c)).

d. Prior to submitting request for final payment to the designer for approval, the CM shall fully comply with all requirements specified in the"project closeout" section of the specifications. These requirements include but not limited to the following:

   1. Submittal of Product and Operating Manuals, Warranties and Bonds, Guarantees, Maintenance Agreements, As-Built Drawings, Certificates of Inspection or Approval

from agencies having jurisdiction. (The designer must approve the Manuals prior to delivery to the Owner).

2. Transfer of required attic stock material and all keys in an organized manner.

3. Record of Owner's training.

4. Resolution of any final inspection discrepancies.

5. Granting access to Contractor's records, if Owner's internal auditors have made a request for such access pursuant to Article 52.

e. The CM shall forward to the designer, the final application for payment along with the following documents:

1. List of minority business subcontractors and material suppliers showing breakdown of contracts amounts and total actual payments to subcontractors and material suppliers.

2. Affidavit of Release of Liens.

3. Affidavit from CM of payment to material suppliers and subcontractors. (See Article 36).

4. Consent of Surety to Final Payment**.**

5. Certificates of state agencies required by state law.

f. The designer will not authorize final payment until the work under contract has been certified by Project Designer, certificates of compliance issued, and the CM has complied with the closeout requirements. The designer shall forward the CM's final application for payment to the Owner along with respective certificate(s) of compliance required by law.

ARTICLE 33 - PAYMENTS WITHHELD

a. The designer with the approval of the State Construction Office may withhold payment for the following reasons:

1. Faulty work not corrected.

2. The unpaid balance on the contract is insufficient to complete the work in the judgment of the designer.

3. To provide for sufficient contract balance to cover liquidated damages that will be assessed against the CM.

b. The Secretary of the Department of Administration may authorize the withholding of payment for the following reasons:

1. Claims filed against the CM or evidence that a claim will be filed.

2. Evidence that Principal Trade or Specialty Contractors have not been paid.

c. The Owner may withhold all or a portion of CM's Project Management Fee costs set forth in the approved schedule of values, if CM has failed to comply with: (1) a request to access its records by Owner's internal auditors pursuant to Article 52; (2) a request for a plan of action and/or recovery schedule under Article 14.j or provide The Owner; (3) a request to provide an electronic copies of Contractor's baseline schedule, updates with all logic used to create the schedules in the original format of the scheduling software; and (4) Contractor's failure to have its Superintendent on the Project full-time.

d. When grounds for withholding payments have been removed, payment will be released. Delay of payment due the CM without cause will make owner liable for payment of interest to the CM in accordance with G.S. 143-134.1. As provided in G.S.143-134.1(e) the owner shall not be liable for interest on payments withheld by the owner for unsatisfactory job progess, defective construction not remedied, disputed work, or third-party claims filed against the owner or reasonable evidence that a third-party claim will be filed.

ARTICLE 34 - MINIMUM INSURANCE REQUIREMENTS

The work under this contract shall not commence until the CM has verified to the Owner that all required insurance and verifying certificates of insurance have been obtained and approved in writing by the Owner. These certificates shall contain a provision that coverage's afforded under the policies will not be cancelled, reduced in amount or coverage's eliminated until at least thirty (30) days after mailing written notice, by certified mail, return receipt requested, to the insured and the Owner of such alteration or cancellation.

a. **Worker's Compensation and Employer's Liability**

The CM shall ensure that it and all Principal Trade and Specialty Contractors shall provide and maintain, during the life of the contract, workmen's compensation insurance, as required by law, as well as employer's liability coverage with minimum limits of $100,000.

b. **Public Liability and Property Damage**

The CM shall ensure that it and all Principal Trade and Specialty Contractors shall provide and maintain, during the life of the contract, comprehensive general liability insurance, including coverage for premises operations, independent contractors, completed operations, products and contractual exposures, as shall protect such contractors from claims arising out of any bodily injury, including accidental death, as well as from claims for property damages which may arise from operations under this contract, whether such operations be by the contractor or by any subcontractor, or by anyone directly or indirectly employed by either of them and the minimum limits of such insurance shall be as follows:

Bodily Injury:	$500,000 per occurrence
Property Damage:	$100,000 per occurrence / $300,000 aggregate

In lieu of limits listed above, a $500,000 combined single limit shall satisfy both conditions.

Such coverage for completed operations must be maintained for at least two (2) years following final acceptance of the work performed under the contract.

c. **Property Insurance (Builder's Risk/Installation Floater)**

The CM shall ensure that it and all Principal Trade and Specialty Contractors shall purchase and maintain property insurance during the life of this contract, upon the entire work at the

site to the full insurable value thereof. This insurance shall include the interests of the Owner, the CM, and subcontractors in the work and shall insure against the perils of fire, extended coverage, and vandalism and malicious mischief. If the Owner is damaged by failure of the CM to purchase or maintain such insurance, then the CM shall bear all reasonable costs properly attributable thereto; the CM shall effect and maintain similar property insurance on portions of the work stored off the site when request for payment per articles so includes such portions.

d. **Deductible**

Any deductible, if applicable to loss covered by insurance provided, is to be borne by the CM and/or the Principal Trade or Specialty Contractor as applicable.

e. **Other Insurance**

The CM shall ensure that it and all Principal Trade and Specialty Contractors shall obtain such additional insurance as may be required by the Owner or by the General Statutes of North Carolina including motor vehicle insurance, in amounts not less than the statutory limits.

f. **Proof of Carriage**

The CM shall ensure that it and all Principal Trade and Specialty Contractors shall furnish the Owner with satisfactory proof of carriage of the insurance required before written approval is granted by the Owner.

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ARTICLE 35 - PERFORMANCE BOND AND PAYMENT BOND

a. The CM shall furnish a performance bond and payment bond executed by a surety company authorized to do business in North Carolina. The bonds shall be in the full contract amount, which shall be in the amount of the GMP for the entire project. Bonds shall be executed in the form bound with the specifications

b. All bonds shall be countersigned by an authorized agent of the bonding company who is licensed to do business in North Carolina.

ARTICLE 36 - CONTRACTOR'S AFFIDAVIT

The final payment of retained amount due the CM on account of the contract shall not become due until the CM has furnished to the Owner through the designer an affidavit signed, sworn and notarized to the effect that all payments for materials, services or subcontracted work to Principal Trade and Specialty Contractors in connection with his contract have been satisfied, and that no claims or liens exist against the CM in connection with this contract. In the event that the CM cannot obtain similar affidavits from the Principal Trade and Specialty Contractors to protect the CM and the Owner from possible liens or claims against the subcontractor, the CM shall state in his affidavit that no claims or liens exist against any subcontractor to the best of his (the CM's) knowledge, and if any appear afterward, the CM shall save the Owner harmless.

ARTICLE 37 - ASSIGNMENTS

The CM shall not assign any portion of this contract nor subcontract in its entirety. Except as may be required under terms of the performance bond or payment bond, no funds or sums of money due or become due the CM under the contract may be assigned.

ARTICLE 38 - USE OF PREMISES

a. The CM shall confine his apparatus, the storage of materials and the operations of his workmen to limits indicated by law, ordinances, permits or directions of the designer and shall not exceed those established limits in his operations.

b. The CM shall not load or permit any part of the structure to be loaded with a weight that will endanger its safety.

c. The CM shall enforce the designer's and owner's instructions regarding signs, advertisements, fires and smoking.

d. No firearms, any type of alcoholic beverages or drugs (other than those prescribed by a physician) will be permitted at the job site.

ARTICLE 39 - CUTTING, PATCHING AND DIGGING

a. The CM shall ensure that all cutting, fitting or patching that may be required to make the work come together properly and fit it to receive or be received by work of other contractors shown upon or reasonably implied by the drawings and specifications for the completed structure, as the designer may direct.

b. Any cost brought about by defective or ill-timed work shall be borne by the party responsible therefor.

c. No Principal Trade or Specialty Contractor shall endanger any work of another such contractor by cutting, digging or other means, nor shall he cut or alter the work of any other such contractor without the consent of the designer and the affected contractor(s).

ARTICLE 40 - UTILITIES, STRUCTURES, SIGNS

a. The CM shall provide necessary and adequate facilities for water, electricity, gas, oil, sewer, and other utility services, which may be necessary and required for completion of the project. If the Owner specifies that the CM is to pay all utilities, any permanent meters installed shall be listed in the CM's name until his work is fully accepted by the Owner. As stipulated in the Supplementary General Conditions, the Owner may: (1) pay utilities cost directly, (2) require the CM to pay all utilities cost, (3) or reimburse the CM for the actual cost of utilities. The Owner or CM, as applicable, may recover actual costs of metered utilities from the responsible party should delays occur in project completion. Coordination of the work of the utility companies during construction is the sole responsibility of the CM.

b. If applicable Meters shall be relisted in the Owner's name on the day following completion and acceptance of the CM's work, and the Owner shall pay for services used after that date.

c. Prior to the operation of permanent systems, the CM will provide temporary power, lighting, water, and heat to maintain space temperature above freezing, as required for construction operations.

d. The CM shall ensure that the permanent building systems are in sufficient readiness for furnishing temporary climatic control at the time a building is enclosed and secured. The HVAC systems shall maintain climatic control throughout the enclosed portion of the building sufficient to allow completion of the interior finishes of the building. A building shall be considered enclosed and secured when windows**,** doorways (exterior, mechanical, and

electrical equipment rooms), and hardware are installed*;* and other openings have protection, which will provide reasonable climatic control. The appropriate time to start the mechanical systems and climatic condition shall be jointly determined by the CM and the designer. Use of the equipment in this manner shall in no way affect the warranty requirements of the CM.

e. The CM shall coordinate the work so that the building's permanent power wiring distribution system shall be in sufficient readiness to provide power as required by the HVAC contractor for temporary climatic control.

f. The CM shall coordinate the work so that the building's permanent lighting system shall be ready at the time interior painting and finishing begins and shall provide adequate lighting in those areas where interior painting and finishing is being performed.

g. The CM shall be responsible for his permanently fixed service facilities and systems in use during progress of the work. The following procedures shall be strictly adhered to:

    1. Prior to acceptance of work by the State Construction Office, the CM shall coordinate the removal and replacement of any parts of the permanent building systems damaged through use during construction.

    2. Temporary filters as recommended by the equipment manufacturer in orded to keep the equipment and ductwork clean and free of dust and debris shall be installed in each of the heating and air conditioning units and at each return grille during construction. New filters shall be installed in each unit prior to the Owner's acceptance of the work.

    3. Extra effort shall be maintained to keep the building and the site adjacent to the building clean and under no circumstances shall air systems be operated if finishing and site work operations are creating dust in excess of what would be considered normal if the building were occupied.

    4. It shall be understood that any warranty on equipment presented to the Owner shall extend from the day of final acceptance by the Owner. The cost of warranting the equipment during operation in the finishing stages of construction shall be borne by the contractor whose system is utilized.

    5. The CM shall ensure that all lamps are in proper working condition at the time of final project acceptance.

h. The CM shall provide, if required and where directed, a shed for toilet facilities and shall furnish and install in this shed all water closets required for a complete and adequate sanitary arrangement. These facilities will be available to other contractors on the job and shall be kept in a neat and sanitary condition at all times. Chemical toilets are acceptable.

i. The CM shall, if required by the Supplementary General Conditions and where directed, erect a temporary field office, complete with lights, telephone, heat and air conditioning. A portion of this office shall be partitioned off, of sufficient size, for the use of a resident inspector, should the designer so direct.

j. On multi-story construction projects, the CM shall either provide or ensure that temporary elevators, lifts, or other necessary special equipment is available for the general use of all contractors. The cost for such elevators, lifts or other special equipment and the operation thereof shall either be included in the CM Construction Management Fee or specified as part of the work of a Principal Trade or Specialty Contractor and paid for as a part of the Cost of the Work.

k. The CM will erect one sign on the project if required. The sign shall be of sound construction, and shall be neatly lettered with black letters on white background. The sign shall bear the name of the project, and the CM's name, and the name of the designer and consultants. Directional signs may be erected on the Owner's property subject to approval of the Owner with respect to size, style and location of such directional signs. Such signs may bear the name of the contractor and a directional symbol. No other signs will be permitted except by permission of the Owner.

ARTICLE 41 - CLEANING UP

a. The CM shall ensure that the building and surrounding area is reasonably free from rubbish at all times, and shall remove debris from the site on a timely basis or when directed to do so by the designer. The CM shall provide an on-site refuse container(s) for the use of all Principal Trade and Specialty Contractors. The CM shall ensure that each Principal Trade and Specialty Contractor removes their rubbish and debris from the building on a daily basis. The CM shall ensure that the building is broom cleaned as required to minimize dust and dirt accumulation.

b. The CM shall provide and maintain suitable all-weather access to the building**.**

c. Before final inspection and acceptance of the building, the CM shall ensure that all portions of the work are clean, including glass, hardware, fixtures, masonry, tile and marble (using no acid), clean and wax all floors as specified, and completely prepare the building for use by the Owner, with no cleaning required by the Owner.

ARTICLE 42 - GUARANTEE

a. The CM shall unconditionally guarantee materials and workmanship against patent defects arising from faulty materials, faulty workmanship or negligence for a period of twelve (12) months following the date of final acceptance of the work or beneficial occupancy and shall replace such defective materials or workmanship without cost to the Owner.

b. Where items of equipment or material carry a manufacturer's warranty for any period in excess of twelve (12) months, then the manufacturer's warranty shall apply for that particular piece of equipment or material. The CM shall replace such defective equipment or materials, without cost to the Owner, within the manufacturer's warranty period.

c. Additionally, the Owner may bring an action for latent defects caused by the negligence of the CM, which is hidden or not readily apparent to the Owner at the time of beneficial occupancy or final acceptance, whichever occurred first, in accordance with applicable law.

d. Guarantees for roof, equipment, materials, and supplies shall be stipulated in the specifications sections governing such roof, equipment, materials, or supplies.

ARTICLE 43 - CODES AND STANDARDS

Wherever reference is given to codes, standard specifications or other data published by regulating agencies including, but not limited to, national electrical codes, North Carolina State Building Codes, federal specifications, ASTM specifications, various institute specifications, etc., it shall be understood that such reference is to the latest edition including addenda published prior to the date of the contract documents.

ARTICLE 44 - INDEMNIFICATION

To the fullest extent permitted by law, the CM shall indemnify and hold harmless the Owner, the designer and the agents, consultants and employees of the Owner and designer, from and against all claims, damages, losses and expenses, including, but not limited to, attorneys' fees, arising out of or resulting from the performance or failure of performance of the work, provided that any such claim, damage, loss or expense (1) is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the work itself) including the loss of use resulting therefrom, and (2) is caused in whole or in part by any negligent act or omission of the CM, the CM's subcontractor, or the agents of either the CM or the CM's subcontractor. Such obligation shall not be construed to negate, abridge or otherwise reduce any other right or obligation of indemnity which would otherwise exist as to any party or person described in this article.

ARTICLE 45 - TAXES

a. Federal excise taxes do not apply to materials entering into state work (Internal Revenue Code, Section 3442(3)).

b. Federal transportation taxes do not apply to materials entering into state work (Internal Revenue Code, Section 3475(b) as amended).

c. North Carolina sales tax and use tax, as required by law, do apply to materials entering into state work and such costs shall be included in the bid proposal and contract sum.

d. Local option sales and use taxes, as required by law, do apply to materials entering into state work as applicable and such costs shall be included in the bid proposal from Principal Trade and specialty Contractors and contract sum.

e. Accounting Procedures for Refund of County Sales & Use Tax

   Amount of county sales and use tax paid per CM's statements:

   CM's performing contracts for state agencies shall ensure that the Principal Trade and Specialty Contractors provide information to allow the CM to give the state agency for whose project the materials, supplies, fixtures and/or equipment was purchased a signed statement containing the information listed in N.C.G.S. 105-164.14(e).

   The Department of Revenue has agreed that in lieu of obtaining copies of sales receipts from contractors, an agency may obtain a certified statement from the contractors setting forth the date, the type of property and the cost of the property purchased from each vendor, the county in which the vendor made the sale and the amount of local sales and use taxes paid thereon. If the property was purchased out-of-state, the county in which the property was delivered should be listed. The contractor should also be notified that the certified statement may be subject to audit.

   In the event the contractors make several purchases from the same vendor, such certified statement must indicate the invoice numbers, the inclusive dates of the invoices, the total amount of the invoices, the counties, and the county sales and use taxes paid thereon.

   Name of taxing county: The position of a sale is the retailer's place of business located within a taxing county where the vendor becomes contractually obligated to make the sale. Therefore, it is important that the county tax be reported for the county of sale rather than the county of use.

When property is purchased from out-of-state vendors and the county tax is charged, the county should be identified where delivery is made when reporting the county tax.

Such statement must also include the cost of any tangible personal property withdrawn from the contractor's warehouse stock and the amount of county sales or use tax paid thereon by the CM.

Contractors are not to include any tax paid on supplies, tools and equipment which they use to perform their contracts and should include only those building materials, supplies, fixtures and equipment which actually become a part of or annexed to the building or structure.

ARTICLE 46 - EQUAL OPPORTUNITY CLAUSE

The non-discrimination clause contained in Section 202 (Federal) Executive Order 11246, as amended by Executive Order 11375, relative to equal employment opportunity for all persons without regard to race, color, religion, sex or national origin, and the implementing rules and regulations prescribed by the Secretary of Labor, are incorporated herein.

ARTICLE 47 - EMPLOYMENT OF INDIVIDUALS WITH DISABILITIES

The CM agrees not to discriminate against any employee or applicant for employment because of physical or mental handicap in regard to any position for which the employee or applicant is qualified. The CM agrees to take affirmative action to employ, advance in employment and otherwise treat qualified handicapped individuals without discrimination based upon their physical or mental handicap in all employment practices.

ARTICLE 48 - ASBESTOS-CONTAINING MATERIALS (ACM)

The State of North Carolina has attempted to address all asbestos-containing materials that are to be disturbed in the project. However, there may be other asbestos-containing materials in the work areas that are not to be disturbed and do not create an exposure hazard. Construction Managers are reminded of the requirements of instructions under General Conditions of the Contract, titled Examination of Conditions. Statute 130A, Article 19, amended August 3, 1989, established the Asbestos Hazard Management Program that controls asbestos abatement in North Carolina. The latest edition of *Guideline Criteria for Asbestos Abatement* from the State Construction Office is to be incorporated in all asbestos abatement projects for the Capital Improvement Program.

ARTICLE 49 - MINORITY BUSINESS PARTICIPATION

N.C.G.S. 143-128.2 establishes a ten percent (10%) goal for participation by minority businesses in total value of work for each State building project and requires documentation of good faith efforts for meeting that goal. The document, *Guidelines for Recruitment and Selection of Minority Businesses for Participation in State Construction Contracts* including Affidavits and Appendix F are hereby incorporated into and made a part of this contract.

The CM shall identify and define contract packages (the value of which shall total to at least ten percent (10%) of the GMP) that remove barriers to participation commonly experienced by Historically Underutilized Businesses and Minority Business Enterprises as those terms are defined in North Carolina General Statute 143-128.2, hereinafter referred to as Reduced Barrier Packages (RBP). Such contract packages will be submitted to the Owner for review. As an example, RBP's may require no performance or payment bond, or may offer the participation of the CM as a guarantor or surety in the financing of material purchases by the Principal Trade and/or Specialty Contractors, provided that the CM may condition such financing participation upon the

issuance of joint checks or other similar arrangements to allow the CM to verify that timely payments are made to suppliers furnishing credit. The CM may propose other and/or additional provisions for reducing barriers to participation.

The Owner shall require the CM to submit a plan for compliance with N.C.G.S.143-128.2 by approval by the Owner prior to soliciting bids for the Principal Trade and Specialty Contracts. The CM and Principal Trade and Specialty Contractors shall make a good faith effort to recruit and select minority businesses for participation in contracts pursuant to N.C.G.S. 143-128.2.

ARTICLE 50 – CONTRACTOR EVALUATION

The CM's overall work performance on the project shall be fairly evaluated in accordance with the State Building Commission policy and procedures, for determining qualifications to compete for future capital improvement projects for institutions and agencies of the State of North Carolina. In addition to final evaluation, interim evaluation may be prepared during the progress of project. The document, Construction Manager Evaluation Procedures, is hereby incorporated and made a part of this contract. The Owner may request the CM's comments to evaluate the designer.

ARTICLE 51 – GIFTS

Pursuant to N.C. Gen. Stat. § 133-32, it is unlawful for any vendor or contractor (i.e. architect, bidder, contractor, construction manager, design professional, engineer, subcontractor, supplier, vendor, etc.), to make gifts or to give favors to any State employee. This prohibition covers those vendors and contractors who: (1) have a contract with a governmental agency; or (2) have performed under such a contract within the past year; or (3) anticipate bidding on such a contract in the future. For additional information regarding the specific requirements and exemptions, vendors and contractors are encouraged to review G.S. Sec. 133-32.

During the construction of the Project, the Contractor is prohibited from making gifts to any of the Owner's employees, Owner's project representatives (architect, engineers, construction manager and their employees), employees of the State Construction Office and/or any other State employee that may have any involvement, influence, responsibilities, oversight, management and/or duties that pertain to and/or relate to the contract administration, financial administration and/or disposition of claims arising from and/or relating to the Contract and/or Project.

ARTICLE 52 – AUDITING-ACCESS TO PERSONS AND RECORDS

In accordance with N.C. General Statute 147-64.7, the State Auditor shall have access to Contractor's officers, employees, agents and/or other persons in control of and/or responsible for the Contractor's records that relate to this Contracts for purposes of conducting audits under the referenced statute. The Owner's internal auditors shall also have the right to access and copy the Contractor's records relating to the Contract and Project during the term of the Contract and within two years following the completion of the Project/close-out of the Contract to verify accounts, accuracy, information, calculations and/or data affecting and/or relating to Contractor's requests for payment, requests for change orders, change orders, claims for extra work, requests for time extensions and related claims for delay/extended general conditions costs, claims for lost productivity, claims for loss efficiency, claims for idle equipment or labor, claims for price/cost

escalation, pass-through claims of subcontractors and/or suppliers, and/or any other type of claim for payment or damages from Owner and/or its project representatives.

ARTICLE 53 – NORTH CAROLINA FALSE CLAIMS ACT

The North Carolina False Claims Act ("NCFCA"), N.C Gen. Stat. § 1-605 through 1-618, applies to this Contract. The Contractor should familiarize itself with the entire NCFCA and should seek the assistance of an attorney if it has any questions regarding the NCFCA and its applicability to any requests, demands and/or claims for payment its submits to the State through the contracting state agency, institution, university or community college.

The purpose of the NCFCA "is to deter persons from knowingly causing or assisting in causing the State to pay claims that are false or fraudulent and to provide remedies in the form of treble damages and civil penalties when money is obtained from the State by reason of a false or fraudulent claim." (Section 1-605(b).) A contractor's liability under the NCFCA may arise from, but is not limited to: requests for payment, invoices, billing, claims for extra work, requests for change orders, requests for time extensions, claims for delay damages/extended general conditions costs, claims for loss productivity, claims for loss efficiency, claims for idle equipment or labor, claims for price/cost escalation, pass-through claims of subcontractors and/or suppliers, documentation used to support any of the foregoing requests or claims, and/or any other request for payment from the State through the contracting state agency, institution, university or community college. The parts of the NCFCA that are most likely to be enforced with respect to this type of contract are as follows:

- A "claim" is "[a]ny request or demand, whether under a contract or otherwise, for money or property and whether or not the State has title to the money or property that (i) is presented to an officer, employee, or agent of the State or (ii) is made to a contractor … if the money or property is to be spent or used on the State's behalf or to advance a State program or interest and if the State government: (a) provides or has provided any portion of the money or property that is requested or demanded; or (b) will reimburse such contractor … for any portion of the money or property which is requested or demanded." (Section 1-606(2).)

- "Knowing" and "knowingly." – Whenever a person, with respect to information, does any of the following: (a) Has actual knowledge of the information; (b) Acts in deliberate ignorance of the truth or falsity of the information; and/or (c) Acts in reckless disregard of the truth or falsity of the information. (Section 1-606(4).) Proof of specific intent to defraud is not required. (Section 1-606(4).)

- "Material" means having a natural tendency to influence, or be capable of influencing, the payment or receipt of money or property. (Section 1-606(4).)

- Liability. – "Any person who commits any of the following acts shall be liable to the State for three times the amount of damages that the State sustains because of the act of that person[:] … (1) Knowingly presents or causes to be presented a false or fraudulent claim for payment or

approval. (2) Knowingly makes, uses, or causes to be made or used, a false record or statement material to a false or fraudulent claim. (3) Conspires to commit a violation of subdivision (1), (2) …" (Section 1-607(a)(1), (2).)

- The NCFCA shall be interpreted and construed so as to be consistent with the federal False Claims Act, 31 U.S.C. § 3729, et seq., and any subsequent amendments to that act. (Section 1-616(c).)

  Finally, the contracting state agency, institution, university or community college may refer any suspected violation of the NCFCA by the Contractor to the Attorney General's Office for investigation. Under Section 1-608(a), the Attorney General is responsible for investigating any violation of NCFCA, and may bring a civil action against the Contractor under the NCFCA. The Attorney General's investigation and any civil action relating thereto are independent and not subject to any dispute resolution provision set forth in this Contract. (See Section 1-608(a).)

ARTICLE 54 – TERMINATION FOR CONVENIENCE

a. Owner may at any time and for any reason terminate CM's services and work at Owner's convenience. Upon receipt of such notice, CM shall, unless the notice directs otherwise, immediately discontinue the work and placing of orders for materials, facilities and supplies in connection with the performance of this Agreement.

b. Upon such termination, CM shall be entitled to payment only as follows: (1) the actual cost of the work completed in conformity with this Agreement; plus, (2) such other costs actually incurred by CM as are permitted by the prime contract and approved by Owner; (3) plus ten percent (10%) of the cost of the work referred to in subparagraph (1) above for overhead and profit. There shall be deducted from such sums as provided in this subparagraph the amount of any payments made to CM prior to the date of the termination of this Agreement. CM shall not be entitled to any claim or claim of lien against Owner for any additional compensation or damages in the event of such termination and payment.

Geotechnical Exploration Report
North Carolina Museum of Art Renovations – East Building and Park
Raleigh, North Carolina
S&ME Project No. 24050612

PREPARED FOR:

NC Department of Natural and Cultural Resources
109 East Jones Street
Raleigh, North Carolina 27601

PREPARED BY:

S&ME, Inc.
3201 Spring Forest Road
Raleigh, North Carolina 27616

November 13, 2024

November 13, 2024

NC Department of Natural and Cultural Resources
109 East Jones Street
Raleigh, North Carolina 27601

Attention: Mr. Tony Romaine
Construction Project Manager

Reference: **Geotechnical Exploration Report**
North Carolina Museum of Art Renovations – East Building and Park
Raleigh, North Carolina
S&ME Project No. 24050612

Dear Mr. Romaine:

S&ME, Inc. (S&ME) is pleased to submit this geotechnical exploration report for the referenced project. Our services were performed in general accordance with our proposal No. 24050612 dated September 19, 2024. This report presents a brief discussion of our understanding of the project, results of the exploration, and our geotechnical conclusions and recommendations regarding the proposed construction.

We appreciate the opportunity to work with you on this project. Please contact us with any questions, or if you need additional information.

Sincerely,

S&ME, Inc.

Will Harrison
Associate Project Manager

NORTH CAROLINA PROFESSIONAL SEAL 022540 ENGINEER KEITH C. BROWN

11/13/2024

Keith Brown, P.E.
Senior Vice President/ Senior Engineer
NC Registration No. 022540

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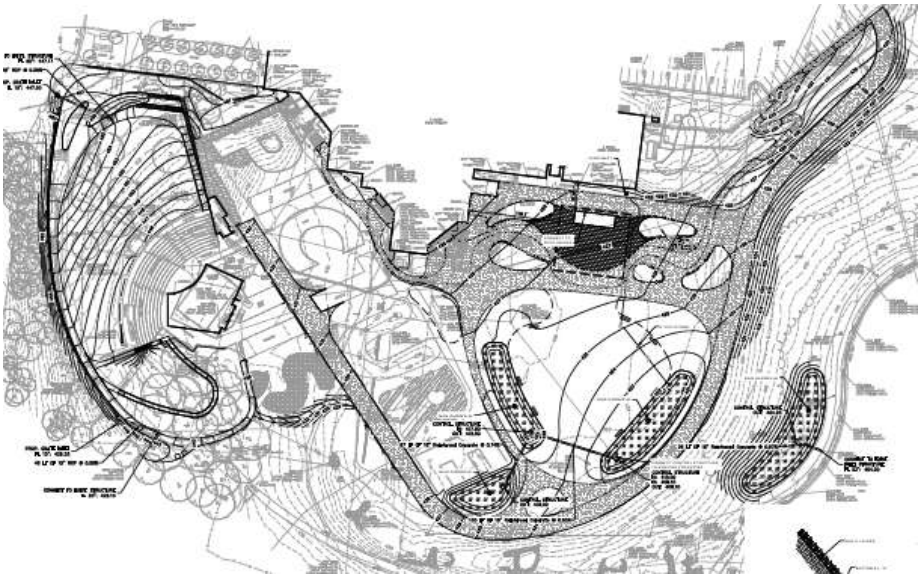
1.0 Project and Site Information

This report is based on the following information:

- Email correspondence between Mr. Tony Romaine, P.E. (NC Department of Natural and Cultural Resources), Mr. Keith Brown, P.E. (S&ME) and Ms. Anita Karimu (HH Architecture) between September 9, 2024 and October 30, 2024.
- *NCMA – East Building and Museum Park Improvements*, dated May 21, 2024 and the 90% Revised CD Set dated October 18, 2024.
- Google Earth aerial imagery.
- Wake County GIS.

We understand the North Carolina Museum of Art in Raleigh in Raleigh North Carolina is currently in the design phase of improvements to the existing east buildings and site improvements. The proposed construction will incorporate a pavilion area, boardwalks, raingarden, pedestrian walkways, retaining walls, and garden areas. We have assumed that maximum column loads for the pavilion structure will be on the order of 60 kips.

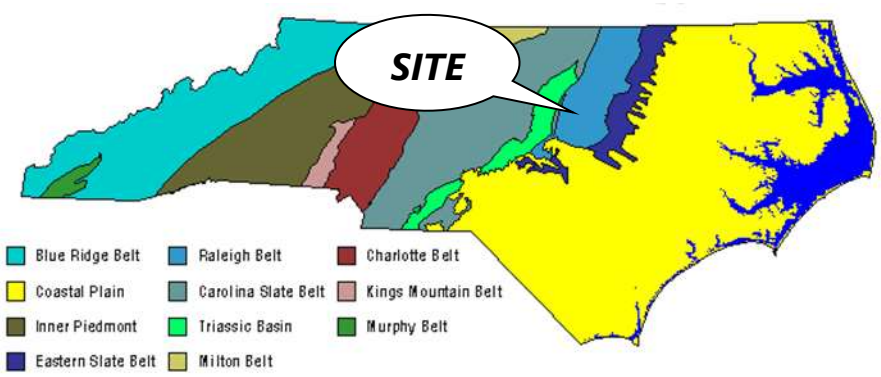
Based on Wake County GIS topographic information, existing site elevations range from about 420 feet in the eastern portion of the site, to about 458 feet in the western portion of the proposed construction area. Based on the provided NCMA 90% CD Plan Set, a concrete fire access lane will extend from the northeast access point to the existing amphitheater. The proposed development is shown below.



At the time of our exploration, planned development areas on site consisted of primarily grassed regions, taller vegetative areas and some gravel drives. Site elevations within the majority of the planned development area (just south of the existing museum structure where the proposed pavilion is located) are generally flat and range from 427 to 432 feet. Based on the proposed grading plan, we anticipate that limited cuts and fills of 3 to 5 feet are expected, with exception to rain garden areas where deeper cuts of 7 to 10 feet are anticipated. Existing site conditions are shown in the Google Earth aerial image below.



2.0 Regional Geology



The site is located within the Raleigh Belt region of the Piedmont Physiographic Province in North Carolina. The parent rock materials in the area primarily consist of gneiss and schist rock. Within the upland areas, soils within the Piedmont Province are the residual product of in-place chemical and physical weathering of parent rock materials. The typical residual profile consists of finer grain silts and clays near the ground surface which gradually transition to coarser and denser material with depth. In many locations, the transition zone between soil and rock is not well defined. Locally, the transition zone is termed partially weathered rock (PWR). For engineering purposes, partially weathered rock is defined as residual material in which standard penetration test values exceed 100 blows per foot.

3.0 Exploration Program

Our geotechnical field evaluation included the performance of a 6 soil test borings labelled (B-1 though B-5 and B-7, B-6 was performed with hand equipment due to its location and steeper topography). Approximate boring locations are shown on the attached Figure 1, Boring Location Plan. Boring locations were established in the field by S&ME using a hand-held GPS and should be considered approximate.

Hand auger borings with associated Sower's Dynamic Cone Penetration (DCP) testing was also performed at eighteen locations (HA-1 through HA-17 and B-6). The Sower's DCP is comprised of a steel extension shaft assembly that incorporates a 45-degree hardened steel cone tip attached to the driving end. The tip is driven into the subgrade by a 15-pound hammer 20 inches. Three increments of 1-3/4 inch are marked on the DCP and the blows that it takes to penetrate each 1-3/4 inch increment are documented. The Sower's DCP testing was performed at the existing ground surface and at intervals of approximately 1 foot in depth thereafter until termination or refusal was encountered. Hand auger borings with associated Sower's DCP testing ranged from approximately .7 feet to 5.5 feet below the existing ground surface.

Borings were drilled using a CME-550 drill rig mounted on an all-terrain vehicle. Borings were advanced using a 3¼-inch inside-diameter hollow stem auger drilling procedures to depths ranging from approximately 5 to 20 feet below the existing ground surface. Split-spoon soil samples were taken at approximate 2½-foot intervals above a depth of 10 feet and then at 5-foot intervals below 10 feet. Standard penetration tests were conducted using an automatic hammer in conjunction with split-spoon sampling in general accordance with ASTM D1586.

Water level measurements were attempted immediately after drilling within all borings. Borings were backfilled with auger cuttings and closed in accordance with our standard borehole closure protocol prior to demobilization.

Test Boring Records and a Generalized Subsurface Profile showing specific subsurface information from each boring are included in the Appendix. Stratification lines shown on Test Boring Records and the Subsurface Profile are intended to represent approximate depths of changes in soil types. Naturally, transitional changes in soil types are often gradual and cannot be defined at exact depths.

Representative split-spoon samples and one bulk sample were returned to our laboratory for visual classification and testing. Soils were classified in general accordance with Unified Soil Classification System guidelines. Laboratory testing include natural moisture content, Atterberg limits and grain size testing for general classification purposes, as well as standard Proctor testing on the bulk sample. Laboratory testing was performed in general accordance with applicable ASTM standards.

4.0 Subsurface Conditions

4.1 Topsoil

A surficial layer of topsoil, approximately 3 to 7 inches in thickness, was encountered at each hand auger or boring location, with exception to HA-6 which was performed in a non-grassed area with no topsoil being encountered. Topsoil is typically a dark-colored soil material containing roots, fibrous matter, and/or other organic components, and is unsuitable for engineering purposes. Topsoil depths provided in this report are based on measurements made during drilling and should be considered approximate. We note that the transition from topsoil to underlying natural soils may be gradual.

4.2 Fill Soils

Existing fill soils were encountered in each hand auger and soil test boring on site, with exception to hand auger boring HA-1 which transitioned from topsoil to residuum. Fill soils sampled were generally comprised of soft to very stiff low to high plasticity silts and clays (USCS classification CH, CL and ML), and medium dense clayey sands (SC). Standard Penetration Test (SPT) N-Values recorded in fill soils varied from 4 to 27 blows per foot (bpf). Relatively low consistency (SPT N-values of 7 blows per foot, bpf, or less) soils were encountered within the upper 5 feet in borings B-1, B-3, B-4 and B-5. Average Sower's DCP values within hand auger borings indicate that existing fill soils on site are generally moderately to well compacted. An exception is HA-14 which is poorly compacted with average DCP values of 4 or less within the upper several feet.

4.3 Residual Soils

Residual soils were encountered underlying the surficial materials and fill soils at each soil test boring location, hand auger boring HA-1 encountered residual soils directly beneath topsoil, the remainder of our hand auger borings terminated (or encountered refusal) within fill soils. The Residual soils encountered were generally found to comprise of clays and silts (USCS designations CL and ML), highly plastic silt (MH), and sands with varying

amounts of clay (SC). SPT N-values recorded in the Residual soils ranged from 2 to 22 blows per foot (bpf) and were generally observed as slightly moist to wet.

4.4 Water Levels

Groundwater level measurements were attempted in each boring at completion of drilling operations. Water was observed several borings and ranged from 18 to 21 feet below the existing ground surface. Perched water is known to exist in this geology and should be expected in unexplored areas of the site. Additionally, surface water that is not effectively gravity-drained, can become perched resulting in horizontal water movement based on local surface slopes. Groundwater levels should be expected to fluctuate with seasonal changes and with rainfall and evaporation rates at other times of the year.

5.0 Laboratory Test Results

A summary of laboratory test results is presented in the following table. Individual laboratory test results are included in Appendix III.

Table 5-1 Summary of Laboratory Test Results

Boring No.	Sample Depth (ft)	Natural Moisture Content (%)	Atterberg Limits		Grain Size Analysis		Standard Proctor		USCS
			Liquid Limit	Plasticity Index	Percent Sand	Percent Fines (Passing #200 Sieve)	Opt. Moisture Content (%)	Max. Dry Unit Weight (pcf)	
B-1	1 – 2 ½	22.3	--	--	--	--	--	--	ML**
B-2	3 ½ – 5	21.9	54	32	42.4	57.6	--	--	CH
B-2	8 ½ – 10	22.5	--	--	--	--	--	--	CL**
B-4	1 – 2 ½	19.2	--	--	--	--	--	--	CL**
B-4	3 ½ - 5	20.6	--	--	--	--	--	--	SC**
B-4	6 – 7 ½	17.3	--	--	--	--	--	--	CL**
B-4*	0 – 5	14.4	37	17	51.4	48.6	16.2	109.7	SC
B-7	1 – 2 ½	17.4	--	--	--	--	--	--	CL**

** Bulk Sample*
*** Visually Classified*
-- Not Tested

6.0 Conclusions and Recommendations

The following sections provide our conclusions and recommendations regarding site development and building foundation support. The recommendations herein are based upon review of test borings, our understanding of the proposed construction, engineering analyses, and experience with similar projects and subsurface conditions. If assumed structural loads, site grades or structure locations are different from those indicated, we should be provided the opportunity to review and comment upon the recommendations of this report so that they may be confirmed, extended, or modified as necessary.

Based on our review of the provided project information, results of our exploration, and our experience with similar conditions, the site is adaptable for the proposed project. The primary geotechnical issues at this site will include:

- **Site Preparation** – The site has been previously developed and as such unexpected conditions should be anticipated. Existing fill soils were encountered in the majority of borings on site. Gravel was encountered in portions of the split-spoon samples and hand auger borings. Gravel will inflate resistance numbers making the soils appear stiffer than they actually are. We recommend that site preparation include the identification and removal of poorly compacted fill below pavement and building areas.
- **Highly Plastic Soils** – Highly plastic existing fill soils were encountered in several borings (B-2 and B-4) at or near the surface where excavation will be required to achieve design subgrade elevation. These soils are highly moisture-sensitive and proper placement and compaction will be difficult. These materials should not be reused as structural fill within the upper two feet of parking subgrade and three feet below design subgrade elevation in building areas or behind retaining structures.
- **Building Support** – The proposed pavilion structure can be supported on conventional shallow foundations if site preparations are performed as described herein.

The following sections present more detailed conclusions and recommendations.

6.1 Earthwork

6.1.1 Site Preparation – General

Borings performed for this exploration indicate topsoil depths of 3 to 7 inches in thickness. Existing gravel from drive areas may be reused as structural fill on site. Initial site preparation should include stripping of topsoil, organics, gravel, underground utilities to be relocated or abandoned, and any other deleterious materials.

Site grading will be difficult during periods of extended rainfall that generally occur during the winter and early spring months. Rutting of near surface soils that will require additional repair occur more frequently during wetter periods of the year. Near-surface soils are moisture sensitive, and when wet, will tend to rut and pump under construction equipment traffic. In addition, these soils are difficult to dry during wet weather conditions. To reduce potential earthwork problems, site preparation and grading should be scheduled during drier summer months, if possible. If grading during wet weather is attempted, repair of near-surface soils and possible use of select off-site borrow will be necessary to adequately prepare subgrades for new construction.

Heavy rubber-tired construction equipment should not be allowed to operate on exposed subgrades during wet conditions. Even during drier periods of the year, we recommend that exposed subgrades be sloped and sealed at the end of each day to promote runoff and reduce infiltration from rainfall. Water should not be allowed to pond on exposed subgrades. To further reduce potential deterioration of exposed subgrades, construction traffic patterns should be managed to limit equipment passes across the site. An all-weather surface may be necessary for heavy construction traffic to reduce degrading the soil subgrade during construction. Options for stabilizing all weather surfaces include compacted crushed stone or chemical (lime) stabilization.

6.1.2 Subgrade Evaluation

After initial site preparation is complete, the exposed subgrade of areas to receive fill and areas near final grades should be evaluated by the geotechnical engineer or their representative. This evaluation should include proofrolling with a full loaded tandem-axle dump truck or similar rubber-tired construction equipment. Any areas that deflect excessively and cannot be densified by rolling should be repaired by undercutting to suitable soils and replacing with compacted structural fill or ABC stone. Depending on prevailing weather conditions at the time of construction, drying, discing, and recompaction of soils may be a suitable alternative to undercutting. This will be a field decision at time of grading. The geotechnical engineer or their representative should observe the overexcavation of the existing tanks and in particular observe the bottom of the excavation, prior to placement of compacted structural fill.

Subgrade repair is anticipated across portions of the site. Soft near surface soils were encountered in the vicinity of borings B-1, 3 and 5 to depths of 3 to 5 feet.

6.1.3 Excavations

Borings indicate that excavations will likely extend through poor to moderate-consistency soils. Poor to moderate-consistency soils can be excavated using backhoes, dozers, and other types of typical earthmoving equipment. Groundwater was not encountered in the borings at termination of drilling, however, perched water conditions are known to exist in this geology and the contractor should be prepared to control groundwater or perched water where encountered within excavations.

Excavations should be sloped or shored in accordance with local, state and federal regulations, including OSHA (29 CFR Part 1926) excavation trench safety standards. The contractor is usually responsible for site safety. This information is provided only as a service and under no circumstances should we be assumed responsible for construction site safety.

6.2 Structural Fill

After site preparation, fill placement operations can proceed. Based on the boring logs, the majority of onsite soils will be suitable for reuse as structural fill. Highly plastic fill soils were encountered at or near final proposed subgrade elevation in portions of the development area. These soils are highly moisture-sensitive and proper placement and compaction will be difficult. Highly plastic materials should not be reused as structural fill within the upper two feet of parking subgrade and three feet below design subgrade elevation in building areas or behind retaining structures. Low plasticity on site soils may be used as fill provided the maximum particle size is less than 3 inches, and the material has less than 3 percent organics and no deleterious materials. The bulk sample

tested in the laboratory was approximately 2 percent dry of their optimum moisture content. Thus, moisture manipulation will likely be required to utilize the soil as structural fill.

Structural fill soil should be placed in 8 to 10-inch thick lifts and compacted to at least 95 percent of the standard Proctor maximum dry density (MDD) (ASTM D 698). The top 12 inches beneath pavements and structures should be compacted to at least 98 percent. The moisture content of structural fill should be maintained at +/- 3 percent of the materials' optimum moisture content. In addition to meeting the compaction criteria, compacted fill must be stable under heavy rubber-tired construction equipment. For some materials, this may require that the moisture content be controlled to a greater tolerance than described above.

Fill placement and compaction should be observed by a qualified soil technician working under the supervision of the geotechnical engineer. An appropriate number of soil density tests should be conducted to confirm that adequate fill compaction is achieved.

6.3 Foundation Recommendations

Building foundations can be supported on shallow spread footings designed for an allowable net soil bearing pressure of 2,000 pounds per square foot (psf). This bearing pressure assumes that footings will bear in approved natural soils or compacted structural fill, and that the site is prepared as recommended herein. This includes undercutting low-consistency soils, properly placing and compacting structural fill, and allowing settlement due to fill to occur prior to foundation construction.

If water collects in any excavations, it should be removed promptly. Care should be exercised during construction of foundations in order not to disturb bearing soils and reduce their bearing strength. Concrete for the footings should be placed as soon as practical following excavation. If concrete placement is delayed, placement of a concrete "mud mat" on exposed bearing soils should be considered.

6.3.1 Bearing Depth and Dimension

Footings should bear at least 18 inches below exterior grade to avoid frost penetration and develop the design bearing capacity. Continuous wall footings should be at least 18 inches wide and isolated column footings should be at least 24 inches wide. This recommendation is made to prevent a localized or "punching" shear failure condition which can occur with very narrow footings.

6.3.2 Settlement

Based on conditions encountered by this exploration, anticipated structural loads, our current understanding of site grading and provided the site is prepared as recommended above, we expect that maximum total settlements beneath footings will be 1 inch or less. Differential settlements are expected to be ½ inch or less.

6.3.3 Footing Evaluations

The bottom of footing excavations should be evaluated by the project geotechnical engineer (or a soils technician working under their direction) using a hand auger and dynamic cone penetrometer (DCP) to gauge the consistency of subgrade soils and determine that subsurface conditions beneath foundation elements agree with

those encountered in the soil borings. Foundation subgrades that are unstable should be over-excavated and replaced with washed (NCDOT #57) stone. The acceptability of #57 stone for use as over-excavation backfill must be evaluated on a case-by-case basis during construction considering the potential for undermining due to future adjoining excavations, underground repair work, interference with subdrains, etc. Washed stone should be available to immediately backfill over excavation and not left open and exposed to rainfall where pooling within the stone can occur.

6.4 Retaining Walls

General recommendations with respect to retaining wall design and construction are provided below along with specific recommendations for cast-in-place concrete walls. Once additional information is available, we should be contacted for any additions or revisions to the recommendations that may be appropriate.

6.4.1 Retaining Walls – General

Retaining walls must be designed to resist lateral earth pressures from the backfill. In addition to the lateral stresses from backfill, the walls may be subjected to surcharge loading from adjacent traffic, stockpiled materials, or stresses from nearby footings or floor slabs. If present, these surcharge stresses should be resolved into appropriate lateral stress distributions and added to the earth pressures outlined below. Walls should have adequate factors of safety against overturning, sliding, and global failure.

We recommend placing a drainage medium, such as clean stone (NCDOT No. 57) wrapped in geotextile fabric or a prefabricated geocomposite drain, behind the wall. The drainage medium should be connected to a footing drain or weep holes to reduce potential buildup of hydrostatic pressure due to surface water, perched water, or utility leaks.

Backfill soils placed behind retaining walls should be of low plasticity and compacted to at least 95 percent of the soil's standard Proctor maximum dry density (ASTM D 698) and within 2 percent of optimum moisture. Operating heavy compaction equipment within 5 feet behind the retaining structures can create lateral earth pressures far in excess of those recommended for design. As such, we recommend that hand-operated equipment be used within 5 feet from walls.

6.4.2 Cast-In-Place Concrete Walls

Recommended backfill parameters for select on-site soils are summarized in the table below. S&ME has included onsite soil parameters used during the original design for materials placed behind the existing retaining wall. If off-site borrow is used for wall backfill during new construction, we recommend the off-site borrow have a USCS classification of GW, GP, SW, SP, or SM with less than 25 percent passing the number 200 sieve. The lateral earth pressure coefficients presented below assume no wall friction between the wall and soil backfill (δ = 0 degrees) and are based on placement of properly compacted backfill and a level backfill surface.

Table 6-1 – Recommended Parameters for Cast-In-Place Wall Backfill

Parameter	On-Site Soils	Off-Site Borrow (GW, GP, SW, SP, or SM with <25% Fines)
Friction Angle, ϕ (degrees)	28	32
At-Rest Earth Pressure Coefficient (K_o)	0.53	0.47
At-Rest Equivalent Earth Pressure (psf/ft)	69	61
Active Coefficient Earth Pressure (K_a)	0.36	0.31
Active Equivalent Earth Pressure (psf/ft)	47	40
Passive Earth Pressure Coefficient (K_p)	2.77	3.25
Passive Equivalent Earth Pressure (psf/ft)	360	423
Moist Unit Weight of Backfill (pcf)	130	130
Ultimate Friction Coefficient Between Wall Foundations and Bearing Soils (assumed to be on-site soils)	0.36	

6.5 Floor Slabs

A properly prepared subgrade should be suitable for slab-on-grade support. We recommend a 6-inch thickness of compacted dense graded aggregate (NCDOT ABC gradation) beneath the slab to enhance uniform slab support. A vapor retarder should be included in the slab design if vapor penetration is an unacceptable condition. The slab subgrade should be evaluated by proofrolling with overlapping passes of a loaded tandem-axle dump truck or similar pneumatic tire vehicle with a minimum weight of 20 tons immediately prior to placement of concrete. Provided subgrade materials are stable under proofrolling, a modulus of subgrade reaction value (k-value) of 125 psi/inch may be used for slab-on-grade design.

6.6 Seismic Site Classification

Based on our test borings and Section 1613 of the North Carolina Building Code 2018 Edition, the site is a **Seismic Site Class D**.

6.7 Pavements – Fire Access

Pavement design procedures are based on AASHTO "Guide for Design of Pavement Structures" (1993) and associated literature. We have assumed an aerial platform rear mount – tandem rear axle emergency vehicle will use the fire access road once a week for 20 years. We further assume a maximum front axle weight of 24,000 lbs and a tandem rear axle weight of 62,000 lbs. As such we have used a traffic design value of 20,000 equivalent single axle loads. These assumptions should be verified by the design team and S&ME notified if our assumptions are not valid.

6.7.1

6.7.1 Concrete Pavement

A modulus of subgrade reaction of 125pci was used in our design along with a concrete strength of 4,000 psi. We have assumed that load transfer across contraction (saw) joints will be handled by aggregate interlock. All materials and construction methods should conform to the 2024 edition of the NCDOT "Standard Specifications for Roads and Structures. The table below presents our recommended concrete pavement section thicknesses.

Table 6-2 – Proposed Concrete Pavement Section

Material Type	Thickness
Air Entrained Concrete (4000 psi)	6 inches
Aggregate Base Course (ABC) stone	6 inches
Maximum Joint Spacing	12 feet in all directions

Saw joints should be cut to a depth of at least ¼ of the thickness of the concrete pavement to promote shrinkage cracking along the joint. The NCDOT ABC stone should be compacted to at least 98 percent of its modified Proctor maximum dry density. In-place density tests of subgrade soils and crushed stone base course should be performed by a qualified soils technician and the area should be thoroughly proofrolled under his observation.

7.0 Limitations of Report

This report has been prepared in accordance with generally accepted geotechnical engineering practice for specific application to this project. The conclusions and recommendations contained in this report are based upon applicable standards of our practice in this geographic area at the time this report was prepared. No other representation or warranty either express or implied, is made.

We relied on project information given to us to develop our conclusions and recommendations. If project information described in this report is not accurate, or if it changes during project development, we should be notified of the changes so that we can modify our recommendations based on this additional information if necessary.

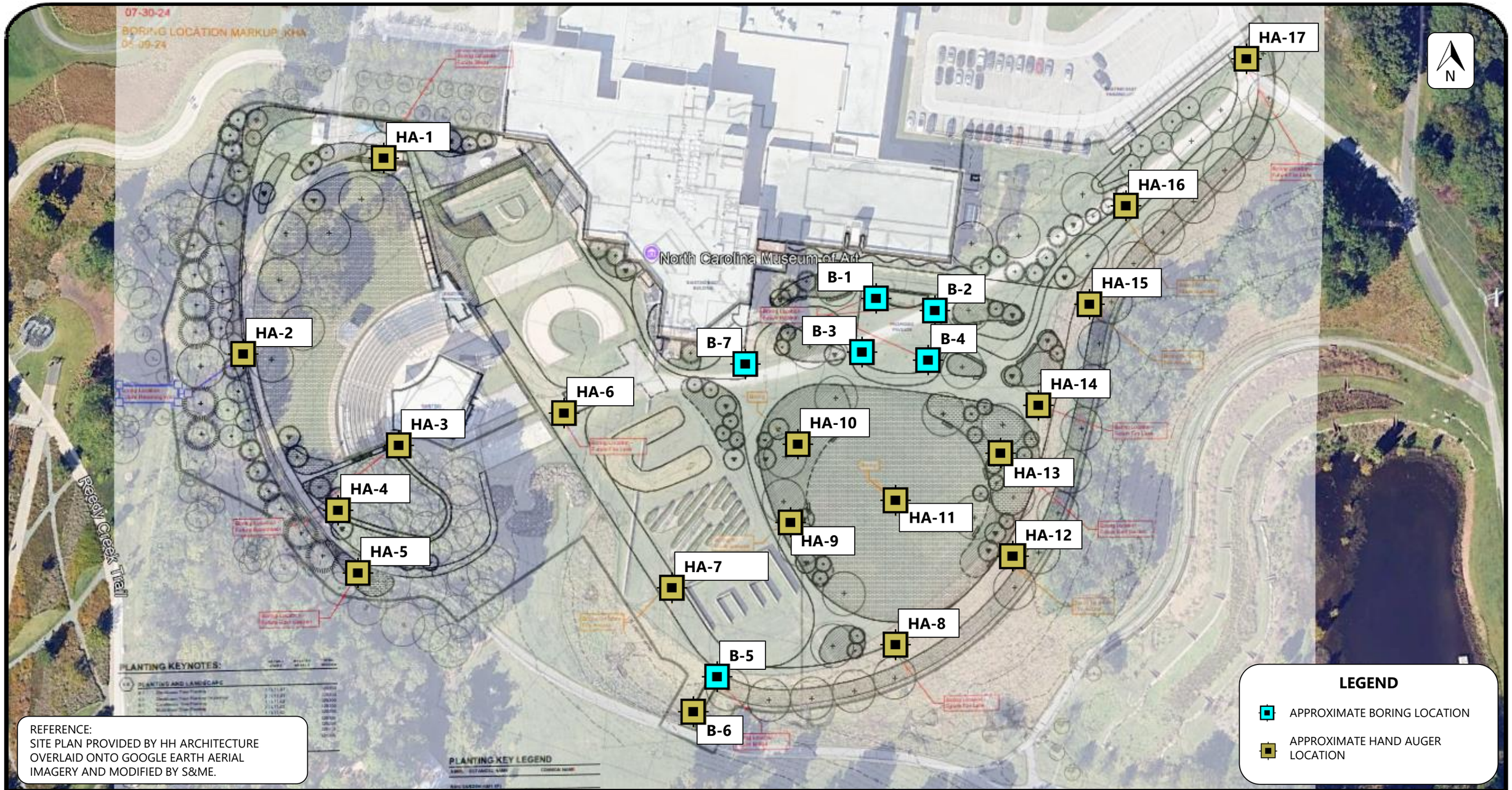
Our conclusions and recommendations are based on limited data from a field exploration program. Subsurface conditions can vary widely between explored areas. Some variations may not become evident until construction. If conditions are encountered which appear different than those described in our report, we should be notified. This report should not be construed to represent subsurface conditions for the entire site.

Unless specifically noted otherwise, our field exploration program did not include an assessment of regulatory compliance, environmental conditions or pollutants or presence of any biological materials (mold, fungi, bacteria). If there is a concern about these items, other studies should be performed. S&ME can provide a proposal and perform these services if requested.

S&ME should be retained to review the final plans and specifications to confirm that earthwork, foundation, and other recommendations are properly interpreted and implemented. The recommendations in this report are contingent on S&ME's review of final plans and specifications followed by our observation and monitoring of earthwork and foundation construction activities.

Appendices

Appendix I – Figures



BORING LOCATION PLAN

NC MUSEUM OF ART
BLUE RIDGE ROAD
RALEIGH, NORTH CAROLINA

SCALE:
NOT TO SCALE

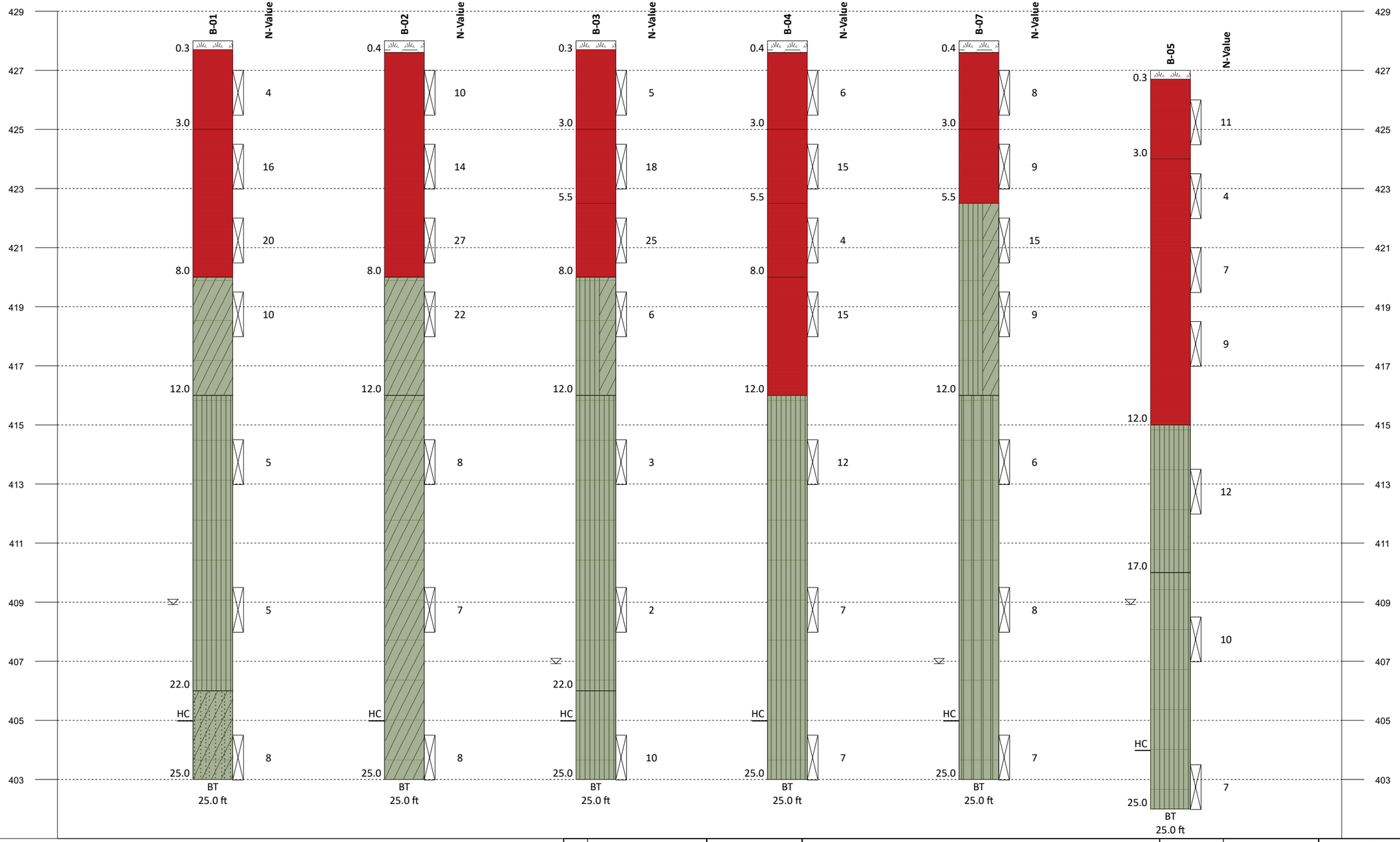
DATE:
10/23/2024

PROJECT NUMBER:
24050612

FIGURE NO.
1

Pavilion Borings

Pavement Borings



Legend Key

- Topsoil
- ML
- CL
- CH
- SC
- CL-ML
- MH

The depicted stratigraphy is shown for illustrative purposes only and is not warranted. Separations between different strata may be gradual and likely vary considerably from those shown. Profiles between nearby borings have been estimated using reasonable engineering care and judgement. The actual subsurface conditions will vary between boring locations.

"AR" = Auger Refusal, "BT = Boring Termination

▽	AT TIME OF DRILLING
▼	END OF DRILLING
▼	AFTER DRILLING

Generalized Subsurface Conditions

NCMA Renovations
Raleigh, NC

SCALE:	Not to scale
DATE:	Nov 11, 2024
PROJECT NUMBER:	24050612

FIGURE NO.

2

Appendix II – Exploration Procedures and Data

♦ Summary of Exploration Procedures

The American Society for Testing and Materials (ASTM) publishes standard methods to explore soil, rock and ground water conditions in Practice D-420-18, "*Standard Guide for Site Characterization for Engineering Design and Construction Purposes.*" The boring and sampling plan must consider the geologic or topographic setting. It must consider the proposed construction. It must also allow for the background, training, and experience of the geotechnical engineer. While the scope and extent of the exploration may vary with the objectives of the client, each exploration includes the following key tasks:

- Reconnaissance of the Project Area
- Preparation of Exploration Plan
- Layout and Access to Field Sampling Locations
- Field Sampling and Testing of Earth Materials
- Laboratory Evaluation of Recovered Field Samples
- Evaluation of Subsurface Conditions

The standard methods do not apply to all conditions or to every site. Nor do they replace education and experience, which together make up engineering judgment. Finally, ASTM D 420 does not apply to environmental investigations.

♦ Reconnaissance of the Project Area

We walked over the site to note land use, topography, ground cover, and surface drainage. We observed general access to proposed sampling points and noted any existing structures.

Checks for Hazardous Conditions - State law requires that we notify the North Carolina (NC 811) before we drill or excavate at any site. NC 811 is operated by the major water, sewer, electrical, telephone, CATV, and natural gas suppliers of North Carolina. NC 811 forwarded our location request to the participating utilities. Location crews then marked buried lines with colored flags within 72 hours. They did not mark utility lines beyond junction boxes or meters. We checked proposed sampling points for conflicts with marked utilities, overhead power lines, tree limbs, or man-made structures during the site walkover.

♦ Boring and Sampling

Soil Test Boring with Mud Rotary Drilling

Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils. Rotary drilling processes were used to advance the hole and a heavy drilling fluid was circulated in the bore holes to stabilize the sides and flush the cuttings. At regular intervals, drilling tools were removed and soil samples were obtained with a standard 1.4 inch I. D., two-inch O. D., split barrel sampler. The sampler was first seated six inches to penetrate any loose cuttings, then driven an additional 12 inches with blows of a 140-pound hammer falling 30 inches. The number of hammer blows required to drive the sampler through the two final six inch increments was recorded as the penetration resistance (SPT N) value. The N-value, when properly interpreted by qualified professional staff, is an index of the soil strength and foundation support capability.

Soil Test Boring with Hollow Stem Auger Drilling

Soil sampling and penetration testing were performed in general accordance with ASTM D 1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils". Rotary drilling processes were used to advance the boreholes. At regular intervals, the drilling tools were removed and soil samples were obtained with a standard 1.4 inch I. D., two-inch O. D., split barrel sampler. The sampler was first seated six inches to penetrate any loose cuttings, then driven an additional 18 inches with blows of a 140-pound hammer falling 30 inches. The number of hammer blows required to drive the sampler through the two intermediate six inch increments was recorded as the penetration resistance (SPT N) value. The N-value, when properly interpreted by qualified professional staff, is an index of the soil strength and foundation support capability. The bottom 6 inches of each sample recovered in the split barrel sampler was placed in a glass jar, closed with a screw top lid, and labeled.

Hand Auger Borings

Auger borings were advanced using hand-operated augers. The soils encountered were identified in the field by cuttings brought to the surface. Representative samples of the cuttings were placed in plastic bags and transported to the laboratory.

Dynamic Cone Penetrometer (DCP) testing was performed in conjunction within the borings in general accordance with ASTM STP 399, "*Dynamic Cone for Shallow In-Situ Penetration Testing*". At selected intervals, the augers were withdrawn and soil consistency measured with a dynamic cone penetrometer. The conical point of the penetrometer was first seated 1-3/4 inches to penetrate any loose cuttings in the boring, then driven two additional 1-3/4 inch increments by a 15 pound hammer falling 20 inches. The number of hammer blows required to achieve this penetration was recorded. When properly evaluated by qualified professional staff, the blow count is an index to the soil strength. Hand auger borings were backfilled with soil cuttings after termination of drilling. Soil cuttings removed from each hole were collected as a bulk sample for laboratory testing.

Water Level Measurement

Subsurface water levels in the boreholes were measured during the onsite exploration by measuring depths from the existing grade to the current water level using a tape.

Backfilling of Borings

Once subsurface water levels were obtained, boring spoils were backfilled into the open bore holes. Bore holes were backfilled to the existing ground surface or bottom of pavement surface.

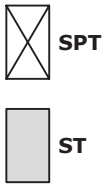
SOIL LOG LEGEND

SOIL PROPERTY SYMBOLS

N - Standard Penetration, bpf
LL - Liquid Limit, %
PPV - Pocket Penetrometer Value, tsf
NMC - Natural Moisture Content, %
PL - Plastic Limit, %
Qu - Unconfined Compressive Strength
F - Fines Content, %
PI - Plasticity Index, %
γd - Dry Unit Weight, pcf

The STANDARD PENETRATION TEST (SPT) as defined by ASTM D1586 (or AASHTO T206) is a method to obtain a disturbed soil sample for examination and testing and to obtain relative density and consistency information. A standard 1.4-inch I.D./2-inch O.D. split-barrel sampler is driven three 6-inch increments with a 140 lb. hammer freely falling 30 inches. The hammer can either be of a trip, free-fall design, or actuated by a rope and cathead. The SPT N Value is determined by adding the number of blows from the 2nd and 3rd 6-inch increments. A normalized blowcount (N_{60}) may be determined by the following equation: N_{60} = [Rig Energy Ratio (%) / 60] * N.

SHELBY TUBE (ST) samples are obtained by hydraulically pushing a thin-walled tube (typically 3-inches in diameter) to obtain a relatively undisturbed sample for testing of fine-grained soils to determine engineering properties such as strength, compressibility, permeability, and density. Shelby tubes are sampled in general accordance with ASTM D1587 (AASHTO T207).



Descriptive Order of Soil Strata: Geologic Disposition (i.e., Fill, Colluvium, Alluvium, etc.), ASTM Group Name (ASTM Group Symbol), quantified/qualified soil constituents, misc. constituents, consistency/density, color, organic description, moisture. ASTM group classifications is determined per ASTM D2487 where lab testing has been performed and ASTM D2488 where lab testing has not been performed.

ASTM GROUP NAME (SYMBOL) AND GRAPHIC

- WELL GRADED GRAVEL (GW)
- POORLY GRADED GRAVEL (GP)
- WELL GRADED GRAVEL WITH SILT (GW-GM)
- WELL GRADED GRAVEL WITH CLAY (GW-GC)
- POORLY GRADED GRAVEL WITH SILT (GP-GM)
- POORLY GRADED GRAVEL WITH CLAY (GP-GC)
- SILTY GRAVEL (GM)
- CLAYEY GRAVEL (GC)
- CLAYEY GRAVEL WITH SILT (GC-GM)
- WELL GRADED SAND (SW)
- POORLY GRADED SAND (SP)
- WELL GRADED SAND WITH SILT (SW-SM)
- WELL GRADED SAND WITH CLAY (SW-SC)
- POORLY GRADED SAND WITH SILT (SP-SM)
- POORLY GRADED SAND WITH CLAY (SP-SC)
- SILTY SAND (SM)
- CLAYEY SAND (SC)
- CLAYEY SAND WITH SILT (SC-SM)
- LEAN CLAY (CL)
- SILTY CLAY (CL-ML)
- SILT (ML)
- FAT CLAY (CH)
- ELASTIC SILT (MH)
- ORGANIC LOW PLASTICITY SILT OR CLAY (OL)
- ORGANIC HIGH PLASTICITY SILT OR CLAY (OH)
- PEAT (PT)
- TOPSOIL
- ASPHALT
- BASE - CEMENT MODIFIED
- BASE - CEMENT STABILIZED AGGREGATE
- BASE - GRAVEL
- CONCRETE
- VOID / NO RECOVERY
- IGM / PWR

FINE-GRAINED SOIL (Relative Consistency)

	N	PPV
Very Soft	< 2 bpf	< 0.25 tsf
Soft	2 - 4 bpf	> 0.25 - 0.5 tsf
Firm	5 - 8 bpf	> 0.5 - 1.0 tsf
Stiff	9 - 15 bpf	> 1.0 - 2.0 tsf
Very Stiff	16 - 30 bpf	> 2.0 - 4.0 tsf
Hard	> 30 bpf	> 4.0 tsf

COARSE-GRAINED SOIL (Relative Density)

	N
Very Loose	< 5 bpf
Loose	5 - 10 bpf
Medium Dense	11 - 30 bpf
Dense	31 - 50 bpf
Very Dense	> 50 bpf

MINOR CONSTITUENTS (% By Weight)

	Percentage
Trace	0% - 10%
Little	11% - 20%
Some	21% - 35%
"And"	≥ 36%

ORGANIC CONTENT OF SOIL (Determined by ASTM D2974 or AASHTO T267)

Classification	Percentage
With Organic Matter	4% - 15%
Organic Soil	16% - 30%
Peat	> 30%

MOISTURE CONDITION

Dry	Absense of moisture, dusty, dry to touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

At Time of Drilling (ATD) — Groundwater observation made anytime during the drilling process. Depending on time of reading and drilling methodologies, this value may be influenced by the drilling process.

End of Drilling — Groundwater measurement soon after the drilling processes are complete, and the borehole is at final depth. Drilling fluids, if introduced during drilling, may influence this measurement.

After Drilling — Groundwater measurements made in a borehole hours to days after drilling is complete. Depending on subsurface conditions, elapsed time, drilling process, etc. this observation may reflect a stabilized level.

REFERENCES:

FHWA NHI-16-072, Geotechnical Engineering Circular No. 5 "Geotechnical Site Characterization"
ASTM Specifications D2487 and D2488
DOT Specifications & Design Manuals from NC, SC, OH, MI, IN, PA, VA.

PROJECT:	NCMA Renovations Raleigh, NC S&ME Project No. 24050612	BORING LOG: B-01 *Sheet 1 of 1*
DATE DRILLED: 10/11/2024	**ELEVATION:** 428 ft	**NOTES:** borehole location and elevation should be considered approximate
DRILL RIG: CME 550	**DATUM:** NAVD88	
DRILLER: David Garrow	**BORING DEPTH:** 25.0 ft	
HAMMER TYPE: Automatic hammer	**CLOSURE:** Cuttings with Hole Closure Device	
DRILLING METHOD: 3-1/4" HSA	**LOGGED BY:** Jarett Swartley	**LATITUDE:** 35.809786 **LONGITUDE:** -78.701876
SAMPLING METHOD: SS	**PROJECT COORDINATE SYSTEM -** World Geodetic System Longitude / Latitude (WGS 84)	

DEPTH (feet)	NOTES	Origin/Identifier	GRAPHIC	SAMPLE NO. (RECOVERY)	MATERIAL DESCRIPTION	BLOW COUNT DATA (SPT N-value)	STANDARD PENETRATION TEST DATA (△ % Fines, ○ NMC, ⊢ PL---LL; 20 40 60 80 100)	ELEVATION
0					TOPSOIL, 3"			428
	0.3			SS-1 (18 in)	SANDY SILT WITH GRAVEL (ML), soft, tan and brown, moist	1-2-2 N = 4		
	3.0	Fill		SS-2 (18 in)	SANDY LEAN CLAY WITH GRAVEL (CL), very stiff, red orange and tan gray, moist	6-6-10 N = 16		
5				SS-3 (18 in)		7-10-10 N = 20		423
	8.0			SS-4 (18 in)	SANDY LEAN CLAY (CL), stiff, tan and orange, moist	3-5-5 N = 10		
10								418
	12.0			SS-5 (18 in)	SANDY SILT (ML), firm, tan and orange, moist to wet	1-3-2 N = 5		
15		Residuum						413
				SS-6 (18 in)		2-2-3 N = 5		
20								408
	Hole caved at 23.0 feet 22.0				CLAYEY SAND (SC), loose, tan, fine grained, wet			
				SS-7 (18 in)		2-3-5 N = 8		
25	25.0				Borehole terminated at 25.0 feet			403
30								398

GROUNDWATER		DATE	DEPTH (FT)	REMARKS
ATD	▽	10/11/2024	19.0	
END OF DRILLING	▼			
AFTER DRILLING	▼			
AFTER DRILLING	▼			

GROUNDWATER DEPTHS ARE NOT EXACT AND MAY VARY SUBSTANTIALLY FROM THOSE INDICATED. ATD = AT TIME OF DRILLING
LL=Liquid Limit, PL = Plastic Limit, NMC = Natural Moisture Content, PPV = Pocket Penetrometer (tsf), PTV = Pocket Torvane (tsf), AR = Auger Refusal, IGM = Intermediate Geomaterial

PROJECT:	NCMA Renovations Raleigh, NC S&ME Project No. 24050612	BORING LOG: B-02 *Sheet 1 of 1*
DATE DRILLED: 10/11/2024	**ELEVATION:** 428 ft	**NOTES:** borehole location and elevation should be considered approximate
DRILL RIG: CME 550	**DATUM:** NAVD88	
DRILLER: David Garrow	**BORING DEPTH:** 25.0 ft	
HAMMER TYPE: Automatic hammer	**CLOSURE:** Cuttings with Hole Closure Device	
DRILLING METHOD: 3-1/4" HSA	**LOGGED BY:** Jarett Swartley	**LATITUDE:** 35.809765 **LONGITUDE:** -78.701683
SAMPLING METHOD: SS	**PROJECT COORDINATE SYSTEM -** World Geodetic System Longitude / Latitude (WGS 84)	

DEPTH (feet)	NOTES	Origin/Identifier	GRAPHIC	SAMPLE NO. (RECOVERY)	MATERIAL DESCRIPTION	BLOW COUNT DATA (SPT N-value)	STANDARD PENETRATION TEST DATA (△ % Fines, ○ NMC, ⊢ PL---LL; 20 40 60 80 100)	ELEVATION
0	0.4	Fill		SS-1 (18 in)	TOPSOIL, 4" SANDY LEAN CLAY WITH GRAVEL (CH), stiff to very stiff, red brown and orange, moist	3-5-5 N = 10		428
				SS-2 (18 in)		3-6-8 N = 14		
5				SS-3 (18 in)		8-13-14 N = 27		423
	8.0							
		Residuum		SS-4 (18 in)	SANDY LEAN CLAY (CL), very stiff, red and orange, moist	6-10-12 N = 22		
10								418
	12.0							
				SS-5 (18 in)	SANDY LEAN CLAY (CL), firm, tan and orange, moist	3-3-5 N = 8		
15								413
				SS-6 (18 in)		2-3-4 N = 7		
20	Hole caved at 23.0 feet							408
				SS-7 (18 in)		2-3-5 N = 8		
25	25.0				Borehole terminated at 25.0 feet			403
30								398

GROUNDWATER		DATE	DEPTH (FT)	REMARKS
ATD	▽	10/11/2024		Not Encountered, Hole Caved @ 23.0'
END OF DRILLING	▼			
AFTER DRILLING	▼			
AFTER DRILLING	▼			

GROUNDWATER DEPTHS ARE NOT EXACT AND MAY VARY SUBSTANTIALLY FROM THOSE INDICATED. ATD = AT TIME OF DRILLING
LL=Liquid Limit, PL = Plastic Limit, NMC = Natural Moisture Content, PPV = Pocket Penetrometer (tsf), PTV = Pocket Torvane (tsf), AR = Auger Refusal, IGM = Intermediate Geomaterial

PROJECT:	NCMA Renovations Raleigh, NC S&ME Project No. 24050612	BORING LOG: B-03 *Sheet 1 of 1*
DATE DRILLED: 10/11/2024	**ELEVATION:** 428 ft	**NOTES:** borehole location and elevation should be considered approximate
DRILL RIG: CME 550	**DATUM:** NAVD88	
DRILLER: David Garrow	**BORING DEPTH:** 25.0 ft	
HAMMER TYPE: Automatic hammer	**CLOSURE:** Cuttings with Hole Closure Device	
DRILLING METHOD: 3-1/4" HSA	**LOGGED BY:** Jarett Swartley	**LATITUDE:** 35.809648 **LONGITUDE:** -78.701902
SAMPLING METHOD: SS	**PROJECT COORDINATE SYSTEM -** World Geodetic System Longitude / Latitude (WGS 84)	

DEPTH (feet)	NOTES	Origin/Identifier	GRAPHIC	SAMPLE NO. (RECOVERY)	MATERIAL DESCRIPTION	BLOW COUNT DATA (SPT N-value)	STANDARD PENETRATION TEST DATA (△ % Fines, ○ NMC, ⊢ PL---LL; 20 40 60 80 100)	ELEVATION
0					TOPSOIL, 3"			428
	0.3	Fill		SS-1 (18 in)	SANDY SILT (ML), firm, tan and orange, moist	1-3-2 N = 5		
	3.0			SS-2 (18 in)	SANDY LEAN CLAY (CL), very stiff, brown and red, moist	6-8-10 N = 18		
5	5.5			SS-3 (18 in)	CLAYEY SAND (SC), medium dense, brown and red, fine grained, moist	8-10-15 N = 25		423
	8.0			SS-4 (18 in)	SILTY CLAY (CL-ML), little mica, firm, tan and red, moist	1-2-4 N = 6		
10	12.0	Residuum			SANDY SILT (ML), soft, moist to wet			418
				SS-5 (18 in)		1-1-2 N = 3		
15								413
				SS-6 (18 in)		1-1-1 N = 2		
20	Hole caved at 23.0 feet							408
	22.0				SANDY SILT (ML), stiff, tan and red, wet			
				SS-7 (18 in)		2-4-6 N = 10		
25	25.0				Borehole terminated at 25.0 feet			403
30								398

GROUNDWATER		DATE	DEPTH (FT)	REMARKS
ATD	▽	10/11/2024	21.0	
END OF DRILLING	▼			
AFTER DRILLING	▼			
AFTER DRILLING	▼			

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LL=Liquid Limit, PL = Plastic Limit, NMC = Natural Moisture Content, PPV = Pocket Penetrometer (tsf), PTV = Pocket Torvane (tsf), AR = Auger Refusal, IGM = Intermediate Geomaterial

PROJECT:	NCMA Renovations Raleigh, NC S&ME Project No. 24050612	BORING LOG: B-04 *Sheet 1 of 1*
DATE DRILLED: 10/11/2024	**ELEVATION:** 428 ft	**NOTES:** borehole location and elevation should be considered approximate
DRILL RIG: CME 550	**DATUM:** NAVD88	
DRILLER: David Garrow	**BORING DEPTH:** 25.0 ft	
HAMMER TYPE: Automatic hammer	**CLOSURE:** Cuttings with Hole Closure Device	
DRILLING METHOD: 3-1/4" HSA	**LOGGED BY:** Jarett Swartley	**LATITUDE:** 35.809628 **LONGITUDE:** -78.701716
SAMPLING METHOD: SS	**PROJECT COORDINATE SYSTEM -** World Geodetic System Longitude / Latitude (WGS 84)	

DEPTH (feet)	NOTES	Origin/Identifier	GRAPHIC	SAMPLE NO. (RECOVERY)	MATERIAL DESCRIPTION	BLOW COUNT DATA (SPT N-value)	STANDARD PENETRATION TEST DATA (△ % Fines, ○ NMC, ⊢ PL---LL; 20 40 60 80 100)	ELEVATION
0					TOPSOIL, 5"			428
	0.4	Fill		SS-1 (18 in)	SANDY LEAN CLAY (CL), firm, red and tan, moist	2-3-3 N = 6	●	
	3.0			SS-2 (18 in)	CLAYEY SAND (SC), medium dense, red and brown, moist	7-8-7 N = 15	●	
5	5.5			SS-3 (18 in)	SANDY LEAN CLAY (CL), soft, red and tan, moist	5-3-1 N = 4	●	423
	8.0			SS-4 (18 in)	SANDY SILT WITH GRAVEL (ML), stiff, tan, moist	4-7-8 N = 15	●	
10	12.0	Residuum		SS-5 (18 in)	SANDY SILT (ML), firm to stiff, red and orange, moist to wet	7-5-7 N = 12	●	418
15								413
				SS-6 (18 in)		3-3-4 N = 7	●	
20	Hole caved at 23.0 feet							408
				SS-7 (18 in)		1-3-4 N = 7	●	
25	25.0				Borehole terminated at 25.0 feet			403
30								398

GROUNDWATER		DATE	DEPTH (FT)	REMARKS
ATD	▽	10/11/2024		Not Encountered, Hole Caved @ 23.0'
END OF DRILLING	▼			
AFTER DRILLING	▼			
AFTER DRILLING	▼			

GROUNDWATER DEPTHS ARE NOT EXACT AND MAY VARY SUBSTANTIALLY FROM THOSE INDICATED. ATD = AT TIME OF DRILLING
LL=Liquid Limit, PL = Plastic Limit, NMC = Natural Moisture Content, PPV = Pocket Penetrometer (tsf), PTV = Pocket Torvane (tsf), AR = Auger Refusal, IGM = Intermediate Geomaterial

PROJECT:	NCMA Renovations Raleigh, NC S&ME Project No. 24050612	BORING LOG: B-05 *Sheet 1 of 1*
DATE DRILLED: 10/14/2024	**ELEVATION:** 427 ft	**NOTES:** borehole location and elevation should be considered approximate
DRILL RIG: CME 550	**DATUM:** NAVD88	
DRILLER: David Garrow	**BORING DEPTH:** 25.0 ft	
HAMMER TYPE: Automatic hammer	**CLOSURE:** Cuttings with Hole Closure Device	
DRILLING METHOD: 3-1/4" HSA	**LOGGED BY:** Jarett Swartley	**LATITUDE:** 35.808858 **LONGITUDE:** -78.702346
SAMPLING METHOD: SS	**PROJECT COORDINATE SYSTEM -** World Geodetic System Longitude / Latitude (WGS 84)	

DEPTH (feet)	NOTES	Origin/Identifier	GRAPHIC	SAMPLE NO. (RECOVERY)	MATERIAL DESCRIPTION	BLOW COUNT DATA (SPT N-value)	STANDARD PENETRATION TEST DATA (△ % Fines, ○ NMC, ⊢ PL---LL; 20 40 60 80 100)	ELEVATION
0								427
	0.3				TOPSOIL, 3"			
		Fill		SS-1 (18 in)	SANDY LEAN CLAY (CL), stiff, brown and tan, moist	4-5-6 N = 11	●	
	3.0							
				SS-2 (18 in)	FAT CLAY (CH), soft to stiff, tan red and orange, moist	1-2-2 N = 4	●	
5								422
				SS-3 (18 in)		3-3-4 N = 7	●	
				SS-4 (18 in)		3-3-6 N = 9	●	
10								417
	12.0				SANDY SILT (ML), stiff, gray, moist to wet			
				SS-5 (18 in)		7-6-6 N = 12	●	
15								412
	17.0				SANDY SILT (ML), little mica, firm to stiff, gray, wet			
		Residuum		SS-6 (18 in)		4-4-6 N = 10	●	
20								407
	Hole caved at 23.0 feet							
				SS-7 (18 in)		2-3-4 N = 7	●	
25	25.0				Borehole terminated at 25.0 feet			402
30								397

GROUNDWATER		DATE	DEPTH (FT)	REMARKS
ATD	▽	10/14/2024	18.0	
END OF DRILLING	▼			
AFTER DRILLING	▼			
AFTER DRILLING	▼			

GROUNDWATER DEPTHS ARE NOT EXACT AND MAY VARY SUBSTANTIALLY FROM THOSE INDICATED. ATD = AT TIME OF DRILLING
LL=Liquid Limit, PL = Plastic Limit, NMC = Natural Moisture Content, PPV = Pocket Penetrometer (tsf), PTV = Pocket Torvane (tsf), AR = Auger Refusal, IGM = Intermediate Geomaterial

PROJECT:	NCMA Renovations Raleigh, NC S&ME Project No. 24050612	HAND AUGER LOG: B-06 *Sheet 1 of 1*
DATE: 10/17/2024	**ELEVATION:** 425 ft	**NOTES:** borehole location and elevation should be considered approximate
EQUIPMENT: Hand Auger	**DATUM:** NAVD88	
OPERATOR: David Garrow	**DEPTH:** 2.5 ft	
HAMMER TYPE: Automatic hammer	**CLOSURE:** Cuttings with Hole Closure Device	
DRILLING METHOD: Hand Auger w/ DCP	**LOGGED BY:** Jarett Swartley	**LATITUDE:** 35.808598 **LONGITUDE:** -78.702475
SAMPLING METHOD:	**PROJECT COORDINATE SYSTEM -** World Geodetic System Longitude / Latitude (WGS 84)	

Depth (feet)	NOTES	DEPOSITIONAL ENVIRONMENT	GRAPHIC	MATERIAL DESCRIPTION	DCP BLOW COUNTS	ELEVATION
0				TOPSOIL, 4"	5-7-9	425
0.4		Fill		SANDY SILT (ML), orange and red, moist		
1					11-16-22	424
2					8-9-10	423
2.5	Auger refusal at 2.5 feet			Bore Hole terminated at 2.5 feet.		
3						422
4						421
5						

GROUNDWATER		DATE	DEPTH (FT)	REMARKS
ATD	▽	10/17/2024		Not Encountered
END OF DRILLING	▼			
AFTER DRILLING	▼			
AFTER DRILLING	▼			

GROUNDWATER DEPTHS ARE NOT EXACT AND MAY VARY SUBSTANTIALLY FROM THOSE INDICATED. ATD = AT TIME OF DRILLING
LL=Liquid Limit, PL = Plastic Limit, NMC = Natural Moisture Content, PPV = Pocket Penetrometer (tsf), PTV = Pocket Torvane (tsf)

PROJECT:	NCMA Renovations Raleigh, NC S&ME Project No. 24050612	BORING LOG: B-07 *Sheet 1 of 1*
DATE DRILLED: 10/14/2024	**ELEVATION:** 428 ft	**NOTES:** borehole location and elevation should be considered approximate
DRILL RIG: CME 550	**DATUM:** NAVD88	
DRILLER: David Garrow	**BORING DEPTH:** 25.0 ft	
HAMMER TYPE: Automatic hammer	**CLOSURE:** Cuttings with Hole Closure Device	
DRILLING METHOD: 3-1/4" HSA	**LOGGED BY:** Jarett Swartley	**LATITUDE:** 35.809617 **LONGITUDE:** -78.702247
SAMPLING METHOD: SS	**PROJECT COORDINATE SYSTEM -** World Geodetic System Longitude / Latitude (WGS 84)	

DEPTH (feet)	NOTES	Origin/Identifier	GRAPHIC	SAMPLE NO. (RECOVERY)	MATERIAL DESCRIPTION	BLOW COUNT DATA (SPT N-value)	STANDARD PENETRATION TEST DATA (△ % Fines, ○ NMC, ⊢ PL---LL; 20 40 60 80 100)	ELEVATION
0	0.4				TOPSOIL, 5"			428
		Fill		SS-1 (18 in)	SANDY LEAN CLAY WITH GRAVEL (CL), firm, orange, moist	2-3-5 N = 8	●	
	3.0			SS-2 (18 in)	SANDY SILT (ML), stiff, tan and red, moist	3-4-5 N = 9	●	
5	5.5			SS-3 (18 in)	SILTY CLAY (CL-ML), stiff, tan and red, moist	4-6-9 N = 15	●	423
				SS-4 (18 in)		3-4-5 N = 9	●	
10	12.0	Residuum			ELASTIC SILT (MH), some mica, firm, brown, moist to wet			418
				SS-5 (18 in)		1-2-4 N = 6	●	
15								413
				SS-6 (18 in)		2-3-5 N = 8	●	
20	Hole caved at 23.0 feet							408
				SS-7 (18 in)		2-3-4 N = 7	●	
25	25.0				Borehole terminated at 25.0 feet			403
30								398

GROUNDWATER		DATE	DEPTH (FT)	REMARKS
ATD	▽	10/14/2024	21.0	
END OF DRILLING	▼			
AFTER DRILLING	▼			
AFTER DRILLING	▼			

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PROJECT:	NCMA Renovations Raleigh, NC S&ME Project No. 24050612	HAND AUGER LOG: HA-01 *Sheet 1 of 1*

DATE: 10/16/2024	**ELEVATION:** 457 ft	**NOTES:** borehole location and elevation should be considered approximate	
EQUIPMENT: Hand Auger	**DATUM:** NAVD88		
OPERATOR: David Garrow	**DEPTH:** 4.5 ft		
HAMMER TYPE:	**CLOSURE:** Cuttings with Hole Closure Device		
DRILLING METHOD: Hand Auger w/ DCP	**LOGGED BY:** Jarett Swartley	**LATITUDE:** 35.810141	**LONGITUDE:** -78.703357
SAMPLING METHOD:	**PROJECT COORDINATE SYSTEM -** World Geodetic System Longitude / Latitude (WGS 84)		

Depth (feet)	NOTES	DEPOSITIONAL ENVIRONMENT	GRAPHIC	MATERIAL DESCRIPTION	DCP BLOW COUNTS	ELEVATION
0				TOPSOIL, 3"		457
0.3					12-12-12	
		Residuum		SANDY SILT (ML), firm to stiff, orange and tan, moist		
1						456
					17-14-15	
2						455
					5-12-11	
3						454
					7-7-10	
4						453
					9-8-8	
4.5	Auger refusal at 4.5 feet			Bore Hole terminated at 4.5 feet.		
5						

GROUNDWATER		DATE	DEPTH (FT)	REMARKS
ATD	▽	10/16/2024		Not Encountered
END OF DRILLING	▼			
AFTER DRILLING	▼			
AFTER DRILLING	▼			

GROUNDWATER DEPTHS ARE NOT EXACT AND MAY VARY SUBSTANTIALLY FROM THOSE INDICATED. ATD = AT TIME OF DRILLING
LL=Liquid Limit, PL = Plastic Limit, NMC = Natural Moisture Content, PPV = Pocket Penetrometer (tsf), PTV = Pocket Torvane (tsf)

PROJECT:	NCMA Renovations Raleigh, NC S&ME Project No. 24050612	HAND AUGER LOG: HA-02 *Sheet 1 of 1*
DATE: 10/16/2024	**ELEVATION:** 452 ft	**NOTES:** borehole location and elevation should be considered approximate
EQUIPMENT: Hand Auger	**DATUM:** NAVD88	
OPERATOR: David Garrow	**DEPTH:** 3.0 ft	
HAMMER TYPE:	**CLOSURE:** Cuttings with Hole Closure Device	
DRILLING METHOD: Hand Auger w/ DCP	**LOGGED BY:** Jarett Swartley	**LATITUDE:** 35.809633 **LONGITUDE:** -78.703708
SAMPLING METHOD:	**PROJECT COORDINATE SYSTEM -** World Geodetic System Longitude / Latitude (WGS 84)	

Depth (feet)	NOTES	DEPOSITIONAL ENVIRONMENT	GRAPHIC	MATERIAL DESCRIPTION	DCP BLOW COUNTS	ELEVATION
0				TOPSOIL, 3"	8-8-8	452
0.3		Fill		SANDY SILT WITH GRAVEL (ML), firm to stiff, red, moist		
1					5-6-8	451
2					8-7-6	450
3					15-15-10	449
3.0	Auger refusal at 3.0 feet			Bore Hole terminated at 3.0 feet.		
4						448
5						

GROUNDWATER		DATE	DEPTH (FT)	REMARKS
ATD	▽	10/16/2024		Not Encountered
END OF DRILLING	▼			
AFTER DRILLING	▼			
AFTER DRILLING	▼			

GROUNDWATER DEPTHS ARE NOT EXACT AND MAY VARY SUBSTANTIALLY FROM THOSE INDICATED. ATD = AT TIME OF DRILLING
LL=Liquid Limit, PL = Plastic Limit, NMC = Natural Moisture Content, PPV = Pocket Penetrometer (tsf), PTV = Pocket Torvane (tsf)

PROJECT:	NCMA Renovations Raleigh, NC S&ME Project No. 24050612	HAND AUGER LOG: HA-03 *Sheet 1 of 1*
DATE: 10/16/2024	**ELEVATION:** 438 ft	**NOTES:** borehole location and elevation should be considered approximate
EQUIPMENT: Hand Auger	**DATUM:** NAVD88	
OPERATOR: David Garrow	**DEPTH:** 2.5 ft	
HAMMER TYPE:	**CLOSURE:** Cuttings with Hole Closure Device	
DRILLING METHOD: Hand Auger w/ DCP	**LOGGED BY:** Jarett Swartley	**LATITUDE:** 35.809407 **LONGITUDE:** -78.703353
SAMPLING METHOD:	**PROJECT COORDINATE SYSTEM -** World Geodetic System Longitude / Latitude (WGS 84)	

Depth (feet)	NOTES	DEPOSITIONAL ENVIRONMENT	GRAPHIC	MATERIAL DESCRIPTION	DCP BLOW COUNTS	ELEVATION
0				TOPSOIL, 3"		438
0.3					12-14-15	
		Fill		SANDY SILT WITH GRAVEL (ML), firm to stiff, red and orange, moist		
1						437
					8-8-8	
2						436
					7-7-8	
2.5	Auger refusal at 2.5 feet			Bore Hole terminated at 2.5 feet.		
3						435
4						434
5						

GROUNDWATER		DATE	DEPTH (FT)	REMARKS
ATD	▽	10/16/2024		Not Encountered
END OF DRILLING	▼			
AFTER DRILLING	▼			
AFTER DRILLING	▼			

GROUNDWATER DEPTHS ARE NOT EXACT AND MAY VARY SUBSTANTIALLY FROM THOSE INDICATED. ATD = AT TIME OF DRILLING
LL=Liquid Limit, PL = Plastic Limit, NMC = Natural Moisture Content, PPV = Pocket Penetrometer (tsf), PTV = Pocket Torvane (tsf)

PROJECT:	NCMA Renovations Raleigh, NC S&ME Project No. 24050612	HAND AUGER LOG: HA-04 *Sheet 1 of 1*
DATE: 10/16/2024	**ELEVATION:** 444 ft	**NOTES:** borehole location and elevation should be considered approximate
EQUIPMENT: Hand Auger	**DATUM:** NAVD88	
OPERATOR: David Garrow	**DEPTH:** 2.5 ft	
HAMMER TYPE:	**CLOSURE:** Cuttings with Hole Closure Device	
DRILLING METHOD: Hand Auger w/ DCP	**LOGGED BY:** Jarett Swartley	**LATITUDE:** 35.809244 **LONGITUDE:** -78.703531
SAMPLING METHOD:	**PROJECT COORDINATE SYSTEM -** World Geodetic System Longitude / Latitude (WGS 84)	

Depth (feet)	NOTES	DEPOSITIONAL ENVIRONMENT	GRAPHIC	MATERIAL DESCRIPTION	DCP BLOW COUNTS	ELEVATION
0				TOPSOIL, 4"	13-11-13	444
0.4		Fill		SANDY SILT WITH GRAVEL (ML), firm to stiff, tan, moist	6-10-14	443
2.5	Auger refusal at 2.5 feet			Bore Hole terminated at 2.5 feet.	8-8-10	442
5						440

GROUNDWATER		DATE	DEPTH (FT)	REMARKS
ATD	▽	10/16/2024		Not Encountered
END OF DRILLING	▼			
AFTER DRILLING	▼			
AFTER DRILLING	▼			

GROUNDWATER DEPTHS ARE NOT EXACT AND MAY VARY SUBSTANTIALLY FROM THOSE INDICATED. ATD = AT TIME OF DRILLING
LL=Liquid Limit, PL = Plastic Limit, NMC = Natural Moisture Content, PPV = Pocket Penetrometer (tsf), PTV = Pocket Torvane (tsf)

PROJECT:	NCMA Renovations Raleigh, NC S&ME Project No. 24050612	HAND AUGER LOG: HA-05 *Sheet 1 of 1*
DATE: 10/16/2024	**ELEVATION:** 448 ft	**NOTES:** borehole location and elevation should be considered approximate
EQUIPMENT: Hand Auger	**DATUM:** NAVD88	
OPERATOR: David Garrow	**DEPTH:** 3.0 ft	
HAMMER TYPE:	**CLOSURE:** Cuttings with Hole Closure Device	
DRILLING METHOD: Hand Auger w/ DCP	**LOGGED BY:** Jarett Swartley	**LATITUDE:** 35.809088 **LONGITUDE:** -78.703458
SAMPLING METHOD:	**PROJECT COORDINATE SYSTEM -** World Geodetic System Longitude / Latitude (WGS 84)	

Depth (feet)	NOTES	DEPOSITIONAL ENVIRONMENT	GRAPHIC	MATERIAL DESCRIPTION	DCP BLOW COUNTS	ELEVATION
0				TOPSOIL, 3"		448
0.3					14-15-14	
				SANDY SILT WITH GRAVEL (ML), firm to stiff, moist		
1						447
1.0		Fill		SILTY CLAY (CL-ML), little mica, firm to stiff, orange, moist	10-8-10	
2						446
					8-10-11	
					10-12-13	
3.0						
3	Auger refusal at 3.0 feet			Bore Hole terminated at 3.0 feet.		445
4						444
5						

GROUNDWATER		DATE	DEPTH (FT)	REMARKS
ATD	▽	10/16/2024		Not Encountered
END OF DRILLING	▼			
AFTER DRILLING	▼			
AFTER DRILLING	▼			

GROUNDWATER DEPTHS ARE NOT EXACT AND MAY VARY SUBSTANTIALLY FROM THOSE INDICATED. ATD = AT TIME OF DRILLING
LL=Liquid Limit, PL = Plastic Limit, NMC = Natural Moisture Content, PPV = Pocket Penetrometer (tsf), PTV = Pocket Torvane (tsf)

PROJECT:	NCMA Renovations Raleigh, NC S&ME Project No. 24050612	HAND AUGER LOG: HA-06 *Sheet 1 of 1*
DATE: 10/17/2024	**ELEVATION:** 430 ft	**NOTES:** borehole location and elevation should be considered approximate
EQUIPMENT: Hand Auger	**DATUM:** NAVD88	
OPERATOR: David Garrow	**DEPTH:** 0.7 ft	
HAMMER TYPE:	**CLOSURE:** Cuttings with Hole Closure Device	
DRILLING METHOD: Hand Auger w/ DCP	**LOGGED BY:** Jarett Swartley	**LATITUDE:** 35.809504 **LONGITUDE:** -78.702852
SAMPLING METHOD:	**PROJECT COORDINATE SYSTEM -** World Geodetic System Longitude / Latitude (WGS 84)	

Depth (feet)	NOTES	DEPOSITIONAL ENVIRONMENT	GRAPHIC	MATERIAL DESCRIPTION	DCP BLOW COUNTS	ELEVATION
0		Fill		SILTY SAND (SM), medium dense to dense, tan, fine grained, dry to moist	22-23-21	430
0.7	Auger refusal at 0.7 feet			Bore Hole terminated at 0.7 feet.		
1						429
2						428
3						427
4						426
5						

GROUNDWATER		DATE	DEPTH (FT)	REMARKS
ATD	▽	10/17/2024		Not Encountered
END OF DRILLING	▼			
AFTER DRILLING	▼			
AFTER DRILLING	▼			

GROUNDWATER DEPTHS ARE NOT EXACT AND MAY VARY SUBSTANTIALLY FROM THOSE INDICATED. ATD = AT TIME OF DRILLING
LL=Liquid Limit, PL = Plastic Limit, NMC = Natural Moisture Content, PPV = Pocket Penetrometer (tsf), PTV = Pocket Torvane (tsf)

PROJECT:	NCMA Renovations Raleigh, NC S&ME Project No. 24050612	HAND AUGER LOG: HA-07 *Sheet 1 of 1*
DATE: 10/17/2024	**ELEVATION:** 427 ft	**NOTES:** borehole location and elevation should be considered approximate
EQUIPMENT: Hand Auger	**DATUM:** NAVD88	
OPERATOR: David Garrow	**DEPTH:** 3.5 ft	
HAMMER TYPE:	**CLOSURE:** Cuttings with Hole Closure Device	
DRILLING METHOD: Hand Auger w/ DCP	**LOGGED BY:** Jarett Swartley	**LATITUDE:** 35.809067 **LONGITUDE:** -78.702502
SAMPLING METHOD:	**PROJECT COORDINATE SYSTEM -** World Geodetic System Longitude / Latitude (WGS 84)	

Depth (feet)	NOTES	DEPOSITIONAL ENVIRONMENT	GRAPHIC	MATERIAL DESCRIPTION	DCP BLOW COUNTS	ELEVATION
0				TOPSOIL, 5"	6-7-9	427
0.4		Fill		SILTY CLAY (CL-ML), soft to stiff, red and orange, moist		
1					8-14-16	426
2					3-2-3	425
3					12-5-6	424
3.5	Auger refusal at 3.5 feet			Bore Hole terminated at 3.5 feet.		
4						423
5						

GROUNDWATER		DATE	DEPTH (FT)	REMARKS
ATD	▽	10/17/2024		Not Encountered
END OF DRILLING	▼			
AFTER DRILLING	▼			
AFTER DRILLING	▼			

GROUNDWATER DEPTHS ARE NOT EXACT AND MAY VARY SUBSTANTIALLY FROM THOSE INDICATED. ATD = AT TIME OF DRILLING
LL=Liquid Limit, PL = Plastic Limit, NMC = Natural Moisture Content, PPV = Pocket Penetrometer (tsf), PTV = Pocket Torvane (tsf)

PROJECT:	NCMA Renovations Raleigh, NC S&ME Project No. 24050612	HAND AUGER LOG: HA-08 *Sheet 1 of 2*
DATE: 10/11/2024	**ELEVATION:** 425 ft	**NOTES:** borehole location and elevation should be considered approximate
EQUIPMENT: Hand Auger	**DATUM:** NAVD88	
OPERATOR: David Garrow	**DEPTH:** 5.5 ft	
HAMMER TYPE:	**CLOSURE:** Cuttings with Hole Closure Device	
DRILLING METHOD: Hand Auger w/ DCP	**LOGGED BY:** Jarett Swartley	**LATITUDE:** 35.808901 **LONGITUDE:** -78.701803
SAMPLING METHOD:	**PROJECT COORDINATE SYSTEM -** World Geodetic System Longitude / Latitude (WGS 84)	

Depth (feet)	NOTES	DEPOSITIONAL ENVIRONMENT	GRAPHIC	MATERIAL DESCRIPTION	DCP BLOW COUNTS	ELEVATION
0				TOPSOIL, 6"	5-9-12	425
0.5		Fill		SANDY LEAN CLAY (CL), trace gravel, firm to stiff, red, moist	6-9-11	424
1						
2					8-14-16	423
3					15-14-23	422
4					14-15-14	421
5						

GROUNDWATER		DATE	DEPTH (FT)	REMARKS
ATD	▽	10/11/2024		Not Encountered
END OF DRILLING	▼			
AFTER DRILLING	▼			
AFTER DRILLING	▼			

GROUNDWATER DEPTHS ARE NOT EXACT AND MAY VARY SUBSTANTIALLY FROM THOSE INDICATED. ATD = AT TIME OF DRILLING
LL=Liquid Limit, PL = Plastic Limit, NMC = Natural Moisture Content, PPV = Pocket Penetrometer (tsf), PTV = Pocket Torvane (tsf)

PROJECT:	NCMA Renovations Raleigh, NC S&ME Project No. 24050612	HAND AUGER LOG: HA-08 *Sheet 2 of 2*
DATE: 10/11/2024	ELEVATION: 425 ft	NOTES: borehole location and elevation should be considered approximate
EQUIPMENT: Hand Auger	DATUM: NAVD88	
OPERATOR: David Garrow	DEPTH: 5.5 ft	
HAMMER TYPE:	CLOSURE: Cuttings with Hole Closure Device	
DRILLING METHOD: Hand Auger w/ DCP	LOGGED BY: Jarett Swartley	LATITUDE: 35.808901 LONGITUDE: -78.701803
SAMPLING METHOD:	PROJECT COORDINATE SYSTEM - World Geodetic System Longitude / Latitude (WGS 84)	

Depth (feet)	NOTES	DEPOSITIONAL ENVIRONMENT	GRAPHIC	MATERIAL DESCRIPTION	DCP BLOW COUNTS	ELEVATION
		Fill		SANDY LEAN CLAY (CL), trace gravel, firm to stiff, red, moist	10-10-9	
5.5				Bore Hole terminated at 5.5 feet.		
6						419
7						418
8						417
9						416
10						

GROUNDWATER		DATE	DEPTH (FT)	REMARKS
ATD	▽	10/11/2024		Not Encountered
END OF DRILLING	▼			
AFTER DRILLING	▼			
AFTER DRILLING	▼			

GROUNDWATER DEPTHS ARE NOT EXACT AND MAY VARY SUBSTANTIALLY FROM THOSE INDICATED. ATD = AT TIME OF DRILLING
LL=Liquid Limit, PL = Plastic Limit, NMC = Natural Moisture Content, PPV = Pocket Penetrometer (tsf), PTV = Pocket Torvane (tsf)

PROJECT:	NCMA Renovations Raleigh, NC S&ME Project No. 24050612	HAND AUGER LOG: HA-09 *Sheet 1 of 2*
DATE: 10/17/2024	**ELEVATION:** 428 ft	**NOTES:** borehole location and elevation should be considered approximate
EQUIPMENT: Hand Auger	**DATUM:** NAVD88	
OPERATOR: David Garrow	**DEPTH:** 5.5 ft	
HAMMER TYPE:	**CLOSURE:** Cuttings with Hole Closure Device	
DRILLING METHOD: Hand Auger w/ DCP	**LOGGED BY:** Jarett Swartley	**LATITUDE:** 35.809202 **LONGITUDE:** -78.702163
SAMPLING METHOD:	**PROJECT COORDINATE SYSTEM -** World Geodetic System Longitude / Latitude (WGS 84)	

Depth (feet)	NOTES	DEPOSITIONAL ENVIRONMENT	GRAPHIC	MATERIAL DESCRIPTION	DCP BLOW COUNTS	ELEVATION
0						428
				TOPSOIL, 5"	4-6-8	
0.4						
		Fill		SANDY SILT (ML), trace gravel, firm to stiff, red and brown, moist		
1					10-11-12	427
2					8-10-12	426
2.5				SANDY SILT (ML), with clay, firm to stiff, red and brown, moist		
3					13-11-8	425
4					18-13-13	424
5						

GROUNDWATER		DATE	DEPTH (FT)	REMARKS
ATD	▽	10/11/2024		Not Encountered
END OF DRILLING	▼			
AFTER DRILLING	▼			
AFTER DRILLING	▼			

GROUNDWATER DEPTHS ARE NOT EXACT AND MAY VARY SUBSTANTIALLY FROM THOSE INDICATED. ATD = AT TIME OF DRILLING
LL=Liquid Limit, PL = Plastic Limit, NMC = Natural Moisture Content, PPV = Pocket Penetrometer (tsf), PTV = Pocket Torvane (tsf)

PROJECT:	NCMA Renovations Raleigh, NC S&ME Project No. 24050612	HAND AUGER LOG: HA-09 *Sheet 2 of 2*
DATE: 10/17/2024	ELEVATION: 428 ft	NOTES: borehole location and elevation should be considered approximate
EQUIPMENT: Hand Auger	DATUM: NAVD88	
OPERATOR: David Garrow	DEPTH: 5.5 ft	
HAMMER TYPE:	CLOSURE: Cuttings with Hole Closure Device	
DRILLING METHOD: Hand Auger w/ DCP	LOGGED BY: Jarett Swartley	LATITUDE: 35.809202 LONGITUDE: -78.702163
SAMPLING METHOD:	PROJECT COORDINATE SYSTEM - World Geodetic System Longitude / Latitude (WGS 84)	

Depth (feet)	NOTES	DEPOSITIONAL ENVIRONMENT	GRAPHIC	MATERIAL DESCRIPTION	DCP BLOW COUNTS	ELEVATION
		Fill		SANDY SILT (ML), with clay, firm to stiff, red and brown, moist	8-15-16	
5.5				Bore Hole terminated at 5.5 feet.		
6						422
7						421
8						420
9						419
10						

GROUNDWATER		DATE	DEPTH (FT)	REMARKS
ATD	▽	10/11/2024		Not Encountered
END OF DRILLING	▼			
AFTER DRILLING	▼			
AFTER DRILLING	▼			

GROUNDWATER DEPTHS ARE NOT EXACT AND MAY VARY SUBSTANTIALLY FROM THOSE INDICATED. ATD = AT TIME OF DRILLING
LL=Liquid Limit, PL = Plastic Limit, NMC = Natural Moisture Content, PPV = Pocket Penetrometer (tsf), PTV = Pocket Torvane (tsf)

PROJECT:	NCMA Renovations Raleigh, NC S&ME Project No. 24050612	HAND AUGER LOG: HA-10 *Sheet 1 of 1*
DATE: 10/17/2024	**ELEVATION:** 428 ft	**NOTES:** borehole location and elevation should be considered approximate
EQUIPMENT: Hand Auger	**DATUM:** NAVD88	
OPERATOR: David Garrow	**DEPTH:** 1.5 ft	
HAMMER TYPE:	**CLOSURE:** Cuttings with Hole Closure Device	
DRILLING METHOD: Hand Auger w/ DCP	**LOGGED BY:** Jarett Swartley	**LATITUDE:** 35.809411 **LONGITUDE:** -78.702100
SAMPLING METHOD:	**PROJECT COORDINATE SYSTEM -** World Geodetic System Longitude / Latitude (WGS 84)	

Depth (feet)	NOTES	DEPOSITIONAL ENVIRONMENT	GRAPHIC	MATERIAL DESCRIPTION	DCP BLOW COUNTS	ELEVATION
0				TOPSOIL, 3"		428
0.3					9-15-15	
		Fill		SANDY SILT (ML), trace gravel, firm to stiff, red and orange, moist		
1						427
					8-8-8	
1.5	Auger refusal at 1.5 feet			Bore Hole terminated at 1.5 feet.		
2						426
3						425
4						424
5						

GROUNDWATER		DATE	DEPTH (FT)	REMARKS
ATD	▽	10/17/2024		Not Encountered
END OF DRILLING	▼			
AFTER DRILLING	▼			
AFTER DRILLING	▼			

GROUNDWATER DEPTHS ARE NOT EXACT AND MAY VARY SUBSTANTIALLY FROM THOSE INDICATED. ATD = AT TIME OF DRILLING
LL=Liquid Limit, PL = Plastic Limit, NMC = Natural Moisture Content, PPV = Pocket Penetrometer (tsf), PTV = Pocket Torvane (tsf)

PROJECT:	NCMA Renovations Raleigh, NC S&ME Project No. 24050612	HAND AUGER LOG: HA-11 *Sheet 1 of 1*
DATE: 10/11/2024	**ELEVATION:** 428 ft	**NOTES:** borehole location and elevation should be considered approximate
EQUIPMENT: Hand Auger	**DATUM:** NAVD88	
OPERATOR: David Garrow	**DEPTH:** 3.5 ft	
HAMMER TYPE:	**CLOSURE:** Cuttings with Hole Closure Device	
DRILLING METHOD: Hand Auger w/ DCP	**LOGGED BY:** Jarett Swartley	**LATITUDE:** 35.809274 **LONGITUDE:** -78.701805
SAMPLING METHOD:	**PROJECT COORDINATE SYSTEM -** World Geodetic System Longitude / Latitude (WGS 84)	

Depth (feet)	NOTES	DEPOSITIONAL ENVIRONMENT	GRAPHIC	MATERIAL DESCRIPTION	DCP BLOW COUNTS	ELEVATION
0				TOPSOIL, 6"	9-8-9	428
0.5		Fill		SANDY SILT (ML), trace gravel, firm to stiff, red and brown, moist	15-16-15	
1						427
2					9-7-9	426
3					8-8-9	425
3.5	Auger refusal at 3.5 feet			Bore Hole terminated at 3.5 feet.		
4						424
5						

GROUNDWATER		DATE	DEPTH (FT)	REMARKS
ATD	▽	10/11/2024		Not Encountered
END OF DRILLING	▼			
AFTER DRILLING	▼			
AFTER DRILLING	▼			

GROUNDWATER DEPTHS ARE NOT EXACT AND MAY VARY SUBSTANTIALLY FROM THOSE INDICATED. ATD = AT TIME OF DRILLING
LL=Liquid Limit, PL = Plastic Limit, NMC = Natural Moisture Content, PPV = Pocket Penetrometer (tsf), PTV = Pocket Torvane (tsf)

PROJECT:	NCMA Renovations Raleigh, NC S&ME Project No. 24050612	HAND AUGER LOG: HA-12 *Sheet 1 of 1*
DATE: 10/11/2024	**ELEVATION:** 425 ft	**NOTES:** borehole location and elevation should be considered approximate
EQUIPMENT: Hand Auger	**DATUM:** NAVD88	
OPERATOR: David Garrow	**DEPTH:** 3.5 ft	
HAMMER TYPE:	**CLOSURE:** Cuttings with Hole Closure Device	
DRILLING METHOD: Hand Auger w/ DCP	**LOGGED BY:** Jarett Swartley	**LATITUDE:** 35.809122 **LONGITUDE:** -78.701451
SAMPLING METHOD:	**PROJECT COORDINATE SYSTEM -** World Geodetic System Longitude / Latitude (WGS 84)	

Depth (feet)	NOTES	DEPOSITIONAL ENVIRONMENT	GRAPHIC	MATERIAL DESCRIPTION	DCP BLOW COUNTS	ELEVATION
0				TOPSOIL, 7"	10-13-15	425
0.6						
1		Fill		SANDY LEAN CLAY (CL), trace gravel, firm to stiff, orange, moist	7-11-17	424
2					8-10-10	423
3					7-7-10	422
3.5	Auger refusal at 3.5 feet			Bore Hole terminated at 3.5 feet.		
4						421
5						

GROUNDWATER		DATE	DEPTH (FT)	REMARKS
ATD	▽	10/11/2024		Not Encountered
END OF DRILLING	▼			
AFTER DRILLING	▼			
AFTER DRILLING	▼			

GROUNDWATER DEPTHS ARE NOT EXACT AND MAY VARY SUBSTANTIALLY FROM THOSE INDICATED. ATD = AT TIME OF DRILLING
LL=Liquid Limit, PL = Plastic Limit, NMC = Natural Moisture Content, PPV = Pocket Penetrometer (tsf), PTV = Pocket Torvane (tsf)

PROJECT:	NCMA Renovations Raleigh, NC S&ME Project No. 24050612	HAND AUGER LOG: HA-13 *Sheet 1 of 1*
DATE: 10/11/2024	**ELEVATION:** 428 ft	**NOTES:** borehole location and elevation should be considered approximate
EQUIPMENT: Hand Auger	**DATUM:** NAVD88	
OPERATOR: David Garrow	**DEPTH:** 4.0 ft	
HAMMER TYPE:	**CLOSURE:** Cuttings with Hole Closure Device	
DRILLING METHOD: Hand Auger w/ DCP	**LOGGED BY:** Jarett Swartley	**LATITUDE:** 35.809381 **LONGITUDE:** -78.701451
SAMPLING METHOD:	**PROJECT COORDINATE SYSTEM -** World Geodetic System Longitude / Latitude (WGS 84)	

Depth (feet)	NOTES	DEPOSITIONAL ENVIRONMENT	GRAPHIC	MATERIAL DESCRIPTION	DCP BLOW COUNTS	ELEVATION
0				TOPSOIL, 6"	12-13-15	428
0.5		Fill		SANDY LEAN CLAY (CL), trace gravel, firm to stiff, red, moist		
1					9-12-25/1.5"	427
1.5				CLAYEY SAND (SC), trace gravel, medium dense, red, fine grained, moist		
2					16-25/1.25"	426
2.5				SILTY CLAY (CL-ML), firm to stiff, red, moist		
3					10-11-9	425
4	Equipment refusal at 4.0 feet			Bore Hole terminated at 4.0 feet.		424
5						

GROUNDWATER		DATE	DEPTH (FT)	REMARKS
ATD	▽	10/11/2024		Not Encountered
END OF DRILLING	▼			
AFTER DRILLING	▼			
AFTER DRILLING	▼			

GROUNDWATER DEPTHS ARE NOT EXACT AND MAY VARY SUBSTANTIALLY FROM THOSE INDICATED. ATD = AT TIME OF DRILLING
LL=Liquid Limit, PL = Plastic Limit, NMC = Natural Moisture Content, PPV = Pocket Penetrometer (tsf), PTV = Pocket Torvane (tsf)

PROJECT:	NCMA Renovations Raleigh, NC S&ME Project No. 24050612	HAND AUGER LOG: HA-14 *Sheet 1 of 2*
DATE: 10/12/2024	**ELEVATION:** 427 ft	**NOTES:** borehole location and elevation should be considered approximate
EQUIPMENT: Hand Auger	**DATUM:** NAVD88	
OPERATOR: David Garrow	**DEPTH:** 5.5 ft	
HAMMER TYPE:	**CLOSURE:** Cuttings with Hole Closure Device	
DRILLING METHOD: Hand Auger w/ DCP	**LOGGED BY:** Jarett Swartley	**LATITUDE:** 35.809514 **LONGITUDE:** -78.701347
SAMPLING METHOD:	**PROJECT COORDINATE SYSTEM -** World Geodetic System Longitude / Latitude (WGS 84)	

Depth (feet)	NOTES	DEPOSITIONAL ENVIRONMENT	GRAPHIC	MATERIAL DESCRIPTION	DCP BLOW COUNTS	ELEVATION
0				TOPSOIL, 6"	25	427
0.5		Fill		SANDY SILT (ML), trace gravel, firm to stiff, orange, moist	8-8-9	426
2.0				SILTY CLAY (CL-ML), firm, red, moist	4-4-3	425
3					4-4-5	424
4.0				SANDY LEAN CLAY (CL), stiff, brown, moist	9-12-17	423
5						

GROUNDWATER		DATE	DEPTH (FT)	REMARKS
ATD	▽	10/11/2024		Not Encountered
END OF DRILLING	▼			
AFTER DRILLING	▼			
AFTER DRILLING	▼			

GROUNDWATER DEPTHS ARE NOT EXACT AND MAY VARY SUBSTANTIALLY FROM THOSE INDICATED. ATD = AT TIME OF DRILLING
LL=Liquid Limit, PL = Plastic Limit, NMC = Natural Moisture Content, PPV = Pocket Penetrometer (tsf), PTV = Pocket Torvane (tsf)

PROJECT:	NCMA Renovations Raleigh, NC S&ME Project No. 24050612	HAND AUGER LOG: HA-14 *Sheet 2 of 2*
DATE: 10/12/2024	**ELEVATION:** 427 ft	**NOTES:** borehole location and elevation should be considered approximate
EQUIPMENT: Hand Auger	**DATUM:** NAVD88	
OPERATOR: David Garrow	**DEPTH:** 5.5 ft	
HAMMER TYPE:	**CLOSURE:** Cuttings with Hole Closure Device	
DRILLING METHOD: Hand Auger w/ DCP	**LOGGED BY:** Jarett Swartley	**LATITUDE:** 35.809514 **LONGITUDE:** -78.701347
SAMPLING METHOD:	**PROJECT COORDINATE SYSTEM -** World Geodetic System Longitude / Latitude (WGS 84)	

Depth (feet)	NOTES	DEPOSITIONAL ENVIRONMENT	GRAPHIC	MATERIAL DESCRIPTION	DCP BLOW COUNTS	ELEVATION
		Fill		SANDY LEAN CLAY (CL), stiff, brown, moist	23-15-20	
5.5				Bore Hole terminated at 5.5 feet.		
6						421
7						420
8						419
9						418
10						

GROUNDWATER		DATE	DEPTH (FT)	REMARKS
ATD	▽	10/11/2024		Not Encountered
END OF DRILLING	▼			
AFTER DRILLING	▼			
AFTER DRILLING	▼			

GROUNDWATER DEPTHS ARE NOT EXACT AND MAY VARY SUBSTANTIALLY FROM THOSE INDICATED. ATD = AT TIME OF DRILLING
LL=Liquid Limit, PL = Plastic Limit, NMC = Natural Moisture Content, PPV = Pocket Penetrometer (tsf), PTV = Pocket Torvane (tsf)

PROJECT:	NCMA Renovations Raleigh, NC S&ME Project No. 24050612	HAND AUGER LOG: HA-15 *Sheet 1 of 2*
DATE: 10/11/2024	**ELEVATION:** 424 ft	**NOTES:** borehole location and elevation should be considered approximate
EQUIPMENT: Hand Auger	**DATUM:** NAVD88	
OPERATOR: David Garrow	**DEPTH:** 5.3 ft	
HAMMER TYPE:	**CLOSURE:** Cuttings with Hole Closure Device	
DRILLING METHOD: Hand Auger w/ DCP	**LOGGED BY:** Jarett Swartley	**LATITUDE:** 35.809766 **LONGITUDE:** -78.701208
SAMPLING METHOD:	**PROJECT COORDINATE SYSTEM -** World Geodetic System Longitude / Latitude (WGS 84)	

Depth (feet)	NOTES	DEPOSITIONAL ENVIRONMENT	GRAPHIC	MATERIAL DESCRIPTION	DCP BLOW COUNTS	ELEVATION
0				TOPSOIL, 4"		424
0.3					10-12-11	
		Fill		SILTY CLAY (CL-ML), trace gravel, firm to stiff, red, moist		
1						423
					13-16-25	
2						422
					17-25/1.25"	
3						421
					15-20-22	
4						420
					25	
5						

GROUNDWATER		DATE	DEPTH (FT)	REMARKS
ATD	▽	10/11/2024		Not Encountered
END OF DRILLING	▼			
AFTER DRILLING	▼			
AFTER DRILLING	▼			

GROUNDWATER DEPTHS ARE NOT EXACT AND MAY VARY SUBSTANTIALLY FROM THOSE INDICATED. ATD = AT TIME OF DRILLING
LL=Liquid Limit, PL = Plastic Limit, NMC = Natural Moisture Content, PPV = Pocket Penetrometer (tsf), PTV = Pocket Torvane (tsf)

PROJECT:	NCMA Renovations Raleigh, NC S&ME Project No. 24050612	HAND AUGER LOG: HA-15 *Sheet 2 of 2*
DATE: 10/11/2024	**ELEVATION:** 424 ft	**NOTES:** borehole location and elevation should be considered approximate
EQUIPMENT: Hand Auger	**DATUM:** NAVD88	
OPERATOR: David Garrow	**DEPTH:** 5.3 ft	
HAMMER TYPE:	**CLOSURE:** Cuttings with Hole Closure Device	
DRILLING METHOD: Hand Auger w/ DCP	**LOGGED BY:** Jarett Swartley	**LATITUDE:** 35.809766 **LONGITUDE:** -78.701208
SAMPLING METHOD:	**PROJECT COORDINATE SYSTEM -** World Geodetic System Longitude / Latitude (WGS 84)	

Depth (feet)	NOTES	DEPOSITIONAL ENVIRONMENT	GRAPHIC	MATERIAL DESCRIPTION	DCP BLOW COUNTS	ELEVATION
		Fill		SILTY CLAY (CL-ML), trace gravel, firm to stiff, red, moist	21-25/1.25"	
5.3				Bore Hole terminated at 5.3 feet.		
6						418
7						417
8						416
9						415
10						

GROUNDWATER		DATE	DEPTH (FT)	REMARKS
ATD	▽	10/11/2024		Not Encountered
END OF DRILLING	▼			
AFTER DRILLING	▼			
AFTER DRILLING	▼			

GROUNDWATER DEPTHS ARE NOT EXACT AND MAY VARY SUBSTANTIALLY FROM THOSE INDICATED. ATD = AT TIME OF DRILLING
LL=Liquid Limit, PL = Plastic Limit, NMC = Natural Moisture Content, PPV = Pocket Penetrometer (tsf), PTV = Pocket Torvane (tsf)

PROJECT:	NCMA Renovations Raleigh, NC S&ME Project No. 24050612	HAND AUGER LOG: HA-16 *Sheet 1 of 1*
DATE: 10/11/2024	**ELEVATION:** 429 ft	**NOTES:** borehole location and elevation should be considered approximate
EQUIPMENT: Hand Auger	**DATUM:** NAVD88	
OPERATOR: David Garrow	**DEPTH:** 3.0 ft	
HAMMER TYPE:	**CLOSURE:** Cuttings with Hole Closure Device	
DRILLING METHOD: Hand Auger w/ DCP	**LOGGED BY:** Jarett Swartley	**LATITUDE:** 35.810007 **LONGITUDE:** -78.701094
SAMPLING METHOD:	**PROJECT COORDINATE SYSTEM -** World Geodetic System Longitude / Latitude (WGS 84)	

Depth (feet)	NOTES	DEPOSITIONAL ENVIRONMENT	GRAPHIC	MATERIAL DESCRIPTION	DCP BLOW COUNTS	ELEVATION
0				TOPSOIL, 3"		429
0.3					9-10-12	
		Fill		SANDY SILT (ML), trace gravel, firm to stiff, red, moist		
1						428
					9-12-25	
2						427
					25/1.25"	
3.0				Bore Hole terminated at 3.0 feet.		426
3	Auger refusal at 3.0 feet					
4						425
5						

GROUNDWATER		DATE	DEPTH (FT)	REMARKS
ATD	▽	10/11/2024		Not Encountered
END OF DRILLING	▼			
AFTER DRILLING	▼			
AFTER DRILLING	▼			

GROUNDWATER DEPTHS ARE NOT EXACT AND MAY VARY SUBSTANTIALLY FROM THOSE INDICATED. ATD = AT TIME OF DRILLING
LL=Liquid Limit, PL = Plastic Limit, NMC = Natural Moisture Content, PPV = Pocket Penetrometer (tsf), PTV = Pocket Torvane (tsf)

PROJECT:	NCMA Renovations Raleigh, NC S&ME Project No. 24050612	HAND AUGER LOG: HA-17 *Sheet 1 of 1*
DATE: 10/11/2024	**ELEVATION:** 430 ft	**NOTES:** borehole location and elevation should be considered approximate
EQUIPMENT: Hand Auger	**DATUM:** NAVD88	
OPERATOR: David Garrow	**DEPTH:** 4.0 ft	
HAMMER TYPE:	**CLOSURE:** Cuttings with Hole Closure Device	
DRILLING METHOD: Hand Auger w/ DCP	**LOGGED BY:** Jarett Swartley	**LATITUDE:** 35.810386 **LONGITUDE:** -78.700728
SAMPLING METHOD:	**PROJECT COORDINATE SYSTEM -** World Geodetic System Longitude / Latitude (WGS 84)	

Depth (feet)	NOTES	DEPOSITIONAL ENVIRONMENT	GRAPHIC	MATERIAL DESCRIPTION	DCP BLOW COUNTS	ELEVATION
0				TOPSOIL, 4"	25/1.5"	430
0.3		Fill		SANDY SILT (ML), trace gravel, firm to stiff, red, moist		
1					17-17-18	429
2.0				SILTY CLAY (CL-ML), firm to stiff, red, moist		
2					5-12-16	428
3					7-7-6	427
4.0	Equipment refusal at 4.0 feet			Bore Hole terminated at 4.0 feet.		426
4						
5						

GROUNDWATER		DATE	DEPTH (FT)	REMARKS
ATD	▽	10/11/2024		Not Encountered
END OF DRILLING	▼			
AFTER DRILLING	▼			
AFTER DRILLING	▼			

GROUNDWATER DEPTHS ARE NOT EXACT AND MAY VARY SUBSTANTIALLY FROM THOSE INDICATED. ATD = AT TIME OF DRILLING
LL=Liquid Limit, PL = Plastic Limit, NMC = Natural Moisture Content, PPV = Pocket Penetrometer (tsf), PTV = Pocket Torvane (tsf)

Appendix III – Laboratory Test Data

♦ Summary of Laboratory Procedures

Examination of Recovered Soil Samples

Soil and field records were reviewed in the laboratory by the geotechnical professional. Soils were classified in general accordance with the visual-manual method described in ASTM D 2488, "*Standard Practice for Description and Identification of Soils (Visual-Manual Method)*". Representative soil samples were selected for classification testing to provide grain size and plasticity data to allow classification of the samples in general accordance with the Unified Soil Classification System method described in ASTM D 2487, "*Standard Practice for Classification of Soils for Engineering Purposes*". The geotechnical professional also prepared the final boring and sounding records enclosed with this report.

Moisture Content Testing of Soil Samples by Oven Drying

Moisture content was determined in general conformance with the methods outlined in ASTM D 2216, "*Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil or Rock by Mass*." This method is limited in scope to Group B, C, or D samples of earth materials which do not contain appreciable amounts of organic material, soluble solids such as salt or reactive solids such as cement. This method is also limited to samples which do not contain contamination.

A representative portion of the soil was divided from the sample using one of the methods described in Section 9 of ASTM D 2216. The split portion was then placed in a drying oven and heated to approximately 110 degrees C overnight or until a constant mass was achieved after repetitive weighing. The moisture content of the soil was then computed as the mass of water removed from the sample by drying, divided by the mass of the sample dry, times 100 percent. No attempt was made to exclude any particular particle size from the portion split from the sample.

Percent Fines Determination of Samples

A selected specimen of soils was washed over a No. 200 sieve after being thoroughly mixed and dried. This test was conducted in general accordance with ASTM D 1140, "*Standard Test Method for Amount of Material Finer Than the No. 200 Sieve*." Method A, using water to wash the sample through the sieve without soaking the sample for a prescribed period of time, was used and the percentage by weight of material washing through the sieve was deemed the "percent fines" or percent clay and silt fraction.

Liquid and Plastic Limits Testing

Atterberg limits of the soils was determined generally following the methods described by ASTM D 4318, "*Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.*" Albert Atterberg originally defined "limits of consistency" of fine grained soils in terms of their relative ease of deformation at various moisture contents. In current engineering usage, the *liquid lim*it of a soil is defined as the moisture content, in percent, marking the upper limit of viscous flow and the boundary with a semi-liquid state. The *plastic limit* defines the lower limit of plastic behavior, above which a soil behaves plastically below which it retains its shape upon drying. The *plasticity index* (PI) is the range of water content over which a soil behaves plastically. Numerically, the PI is the difference between liquid limit and plastic limit values.

Representative portions of fine grained Group A, B, C, or D samples were prepared using the wet method described in Section 10.1 of ASTM D 4318. The liquid limit of each sample was determined using the multipoint

method (Method A) described in Section 11. The liquid limit is by definition the moisture content where 25 drops of a hand operated liquid limit device are required to close a standard width groove cut in a soil sample placed in the device. After each test, the moisture content of the sample was adjusted and the sample replaced in the device. The test was repeated to provide a minimum of three widely spaced combinations of N versus moisture content. When plotted on semi-log paper, the liquid limit moisture content was determined by straight line interpolation between the data points at N equals 25 blows.

The plastic limit was determined using the procedure described in Section 17 of ASTM D 4318. A selected portion of the soil used in the liquid limit test was kneaded and rolled by hand until it could no longer be rolled to a 3.2 mm thread on a glass plate. This procedure was repeated until at least 6 grams of material was accumulated, at which point the moisture content was determined using the methods described in ASTM D 2216.

Compaction Tests of Soils Using Standard Effort

Soil placed as engineering fill is compacted to a dense state to obtain satisfactory engineering properties. Laboratory compaction tests provide the basis for determining the percent compaction and water content needed to achieve the required engineering properties, and for controlling construction to assure the required compaction and water contents are achieved. Test procedures generally followed those described by ASTM D 698, *"Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort."*

The relationship between water content and the dry unit weight is determined for soils compacted in either 4 or 6 inch diameter molds with a 5.5 lbf rammer dropped from a height of 12 inches, producing a compactive effort of 15,000 to 25,000 lbf/ft^3. ASTM D 698 provides three alternative procedures depending on material gradation:

Method A
All material passes No. 4 sieve size
4 inch diameter mold
Shall be used if 25 percent or less by weight is retained on No. 4 sieve
Soil in 3 layers with 25 blows per layer
Method B
All material passes 3/8 inch sieve
4 inch diameter mold
Shall be used if 25 percent by weight is retained on the No. 4 sieve and 20 percent or less by weight is retained on the 3/8 Inch sieve.
Soil in 3 layers with 25 blows per layer
Method C
All material passes ¾ inch sieve
6-inch diameter mold
Shall be used if more than 25 percent by weight is retained on the 3/8 inch sieve and less than 30 percent is retained on the ¾inch sieve.
Soil in 3 layers with 56 blows per layer

Soil was compacted in the mold in three layers of approximately equal thickness, each compacted with either 25 or 56 blows of the rammer. After compaction of the sample in the mold, the resulting dry density and moisture content was determined and the procedure repeated. Separate soils were used for each sample point, adjusting the moisture content of the soil as described in Section 10.2 (Moist Preparation Method). The procedure was repeated for a sufficient number of water content values to allow the dry density vs. water content values to be plotted and the *maximum dry density* and *optimum moisture content* to be determined from the resulting curvilinear relationship.

Form No: TR-D2216-T265-2
Revision No. 1
Revision Date: 08/16/17

LABORATORY DETERMINATION OF WATER CONTENT

ASTM D 2216 ☑ *AASHTO T 265* ☐

S&ME, Inc. Raleigh: 3201 Spring Forest Road, Raleigh, NC 27616

Project #:	24050612	Report Date:	10/28/2024
Project Name:	NCMA Renovations	Test Date(s):	10/28 - 10/29/24
Client Name:	Dept. of Natural and Cultural Resources		
Client Address:	Raleigh, NC		
Sample by:	S&ME	Sample Date(s):	Varies
Sampling Method:	Split Spoon & Bulk	Drill Rig :	N/A

Method: **A (1%)** ☐ **B (0.1%)** ☑ Balance ID. 20977 Calibration Date: 2/13/24 Oven ID. 13289 Calibration Date: 8/30/24

Boring No.	Sample No.	Sample Depth	Tare #	Tare Weight	Tare Wt.+ Wet Wt	Tare Wt. + Dry Wt	Water Weight	Percent Moisture
		ft.		grams	grams	grams	grams	%
B-01	SS-1	1-2.5		49.25	273.04	232.26	40.78	22.3%
B-02	SS-2	3.5-5		7.13	195.04	161.23	33.81	21.9%
B-02	SS-4	8.5-10		50.17	289.00	245.08	43.92	22.5%
B-04	SS-1	1-2.5		49.99	268.59	233.38	35.21	19.2%
B-04	SS-2	3.5-5		6.95	189.87	158.68	31.19	20.6%
B-04	SS-3	6-7.5		50.21	248.21	219.04	29.17	17.3%
B-04	Bulk	0-5		6.77	325.01	285.00	40.01	14.4%
B-07	SS-1	1-2.5		49.30	283.44	248.70	34.74	17.4%

Notes / Deviations / References

AASHTO T 265: Laboratory Determination of Moisture Content of Soils
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

Mal Krajan		Laboratory Manager	10/28/2024
Technical Responsibility	*Signature*	*Position*	*Date*

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Form No. TR-D698-2
Revision No. : 1
Revision Date: 07/25/17

MOISTURE - DENSITY REPORT

Quality Assurance

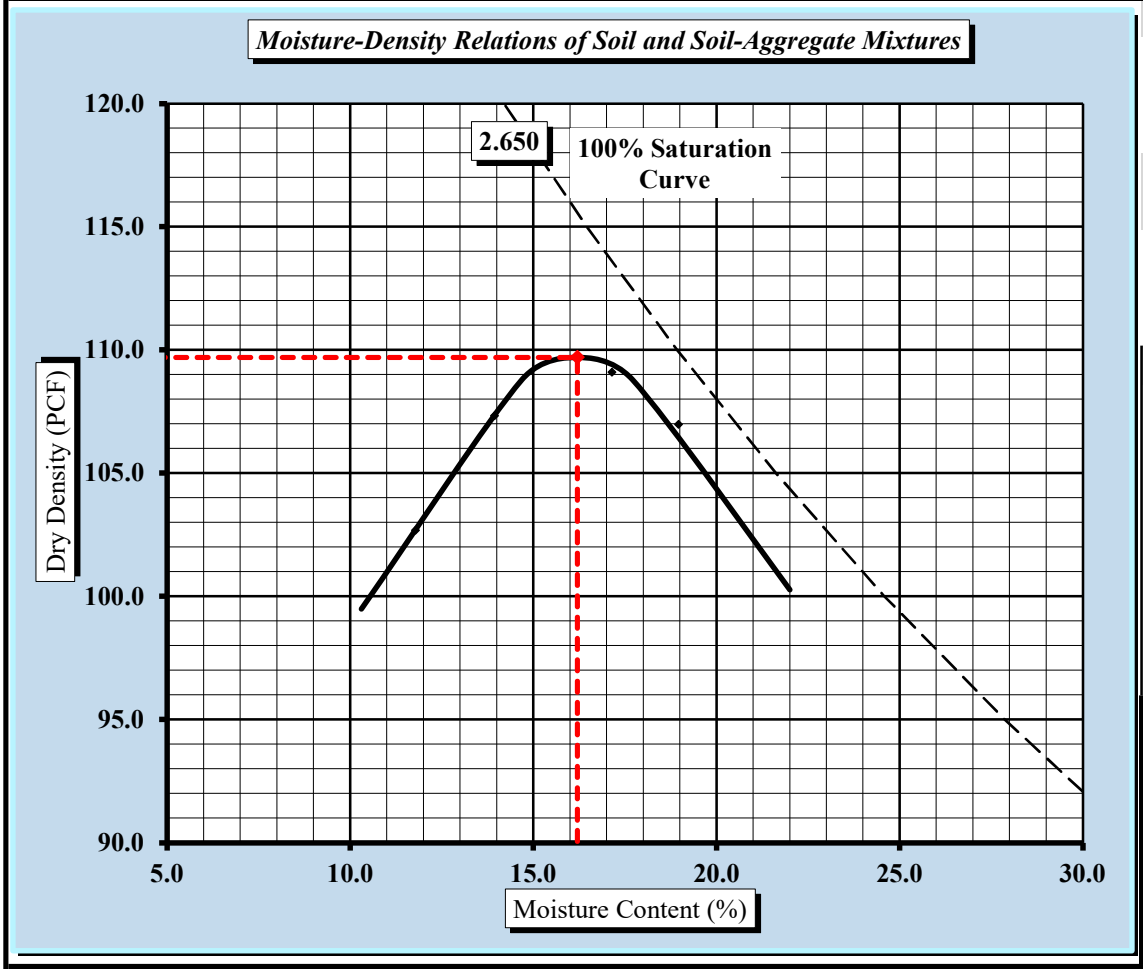
S&ME, Inc. Raleigh: 3201 Spring Forest Road, Raleigh, NC 27616

S&ME Project #:	24050612	Report Date:	10/28/24
Project Name:	NCMA Renovations	Test Date(s):	10/24 - 10/28/24
Client Name:			
Client Address:			

Boring #:	B-4	Sample #:	Bulk	Sample Date:	10/11/2024
Location:	Site Borehole	Offset:	N/A	Depth (ft):	N/A
Sample Description:	Red-Brown Clayey SAND (SC)				

Maximum Dry Density 109.7 PCF. Optimum Moisture Content 16.2%

ASTM D 698 - - Method A



Soil Properties	
Natural Moisture Content	14.4%
Assumed Specific Gravity	2.650
Liquid Limit	37
Plastic Limit	20
Plastic Index	17

% Passing	
3/4"	100.0%
3/8"	97.4%
#4	95.6%
#10	90.8%
#40	80.5%
#60	73.3%
#200	48.6%

Oversize Fraction
Bulk Gravity
% Moisture
% Oversize
MDD
Opt. MC

Moisture-Density Curve Displayed: Fine Fraction ☒ Corrected for Oversize Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☒ 3/4 inch Sieve ☐

Mechanical Rammer ☐ Manual Rammer ☒ Moist Preparation ☐ Dry Preparation ☒

References / Comments / Deviations: ND=Not Determined.

ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

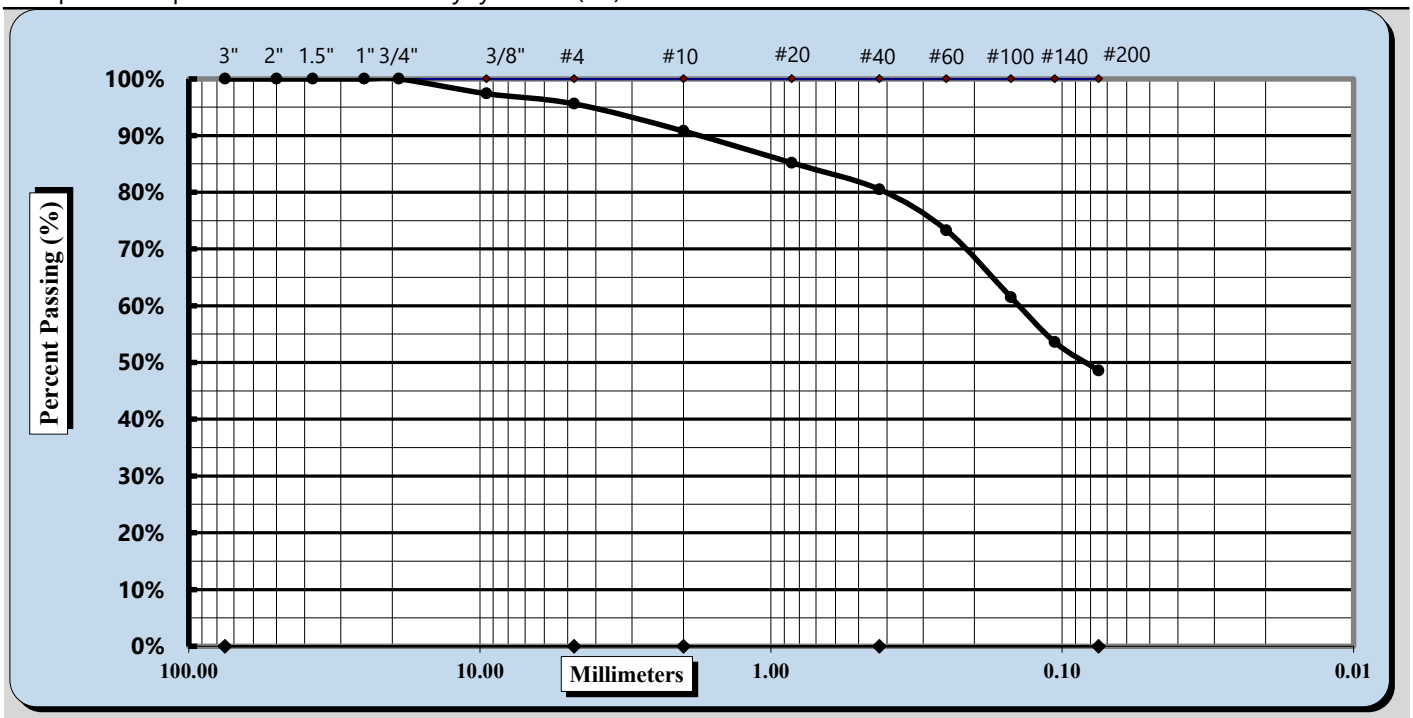
ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort

SIEVE ANALYSIS OF SOIL

Single sieve set ASTM D6913

S&ME, Inc. Raleigh: 3201 Spring Forest Road, Raleigh, NC 27616

Project #:	24050612	Record Date:	10/18/2024
Project Name:	NCMA Renovations	Lab Report #:	1
Client Name:		Date Received:	10/18/2024
Client Address:			
Received By:	Lab Tech	Sampled by: S&ME, Inc.	Date Sampled: 10/11/2024
Location:	Site Borehole	Boring #: N/A	Sample #: Bulk
Log/Sample Id.	312	Type: Bulk	Elev/Depth (ft): 0-5
Sample Description:	Red-Brown Clayey SAND (SC)		



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Method: B Procedure for obtaining Specimen: Moist

Maximum Particle Size	3/4"	Coarse Sand	4.8%	Fine Sand	31.9%
Gravel	4.4%	Medium Sand	10.3%	Silt & Clay	48.6%
Liquid Limit	37	Plastic Limit	20	Plastic Index	17
Maximum Dry Density	109.7 PCF	Bulk Gravity (C127)	N/A	% Absorption	N/A
Optimum Moisture	16.2%	Natural Moisture	14.4%		

Notes / Deviations / References:

Mal Krajan		Laboratory Manager	10/22/2024
Technical Responsibility	*Signature*	*Position*	*Date*

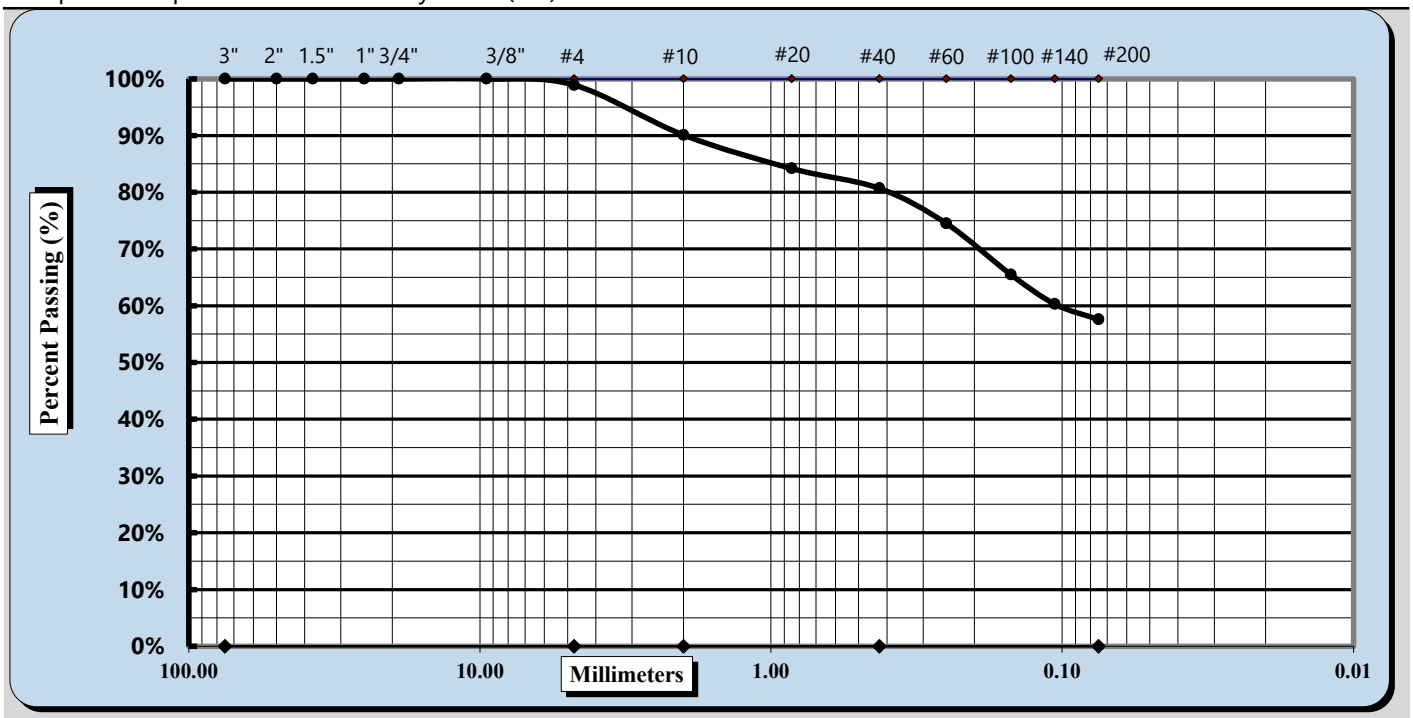
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SIEVE ANALYSIS OF SOIL

Single sieve set ASTM D6913

S&ME, Inc. Raleigh: 3201 Spring Forest Road, Raleigh, NC 27616

Project #:	24050612	Record Date:	10/28/2024
Project Name:	NCMA Renovations	Lab Report #:	1
Client Name:	Department of Natural & Cultural Resources	Date Received:	10/24/2024
Client Address:			
Received By:	Lab Tech	Sampled by: S&ME, Inc.	Date Sampled: N/A
Location:	Site-Borehole	Boring #: B-02	Sample #: SS-2
Log/Sample Id.	321	Type: SS	Elev/Depth (ft): 3.5-5
Sample Description:	Brown Sandy CLAY (CH)		



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Method: B Procedure for obtaining Specimen: Moist

Maximum Particle Size	3/8"	Coarse Sand	8.8%	Fine Sand	23.1%
Gravel	1.1%	Medium Sand	9.4%	Silt & Clay	57.6%
Liquid Limit	54	Plastic Limit	22	Plastic Index	32
Maximum Dry Density	N/A	Bulk Gravity (C127)	N/A	% Absorption	N/A
Optimum Moisture	N/A	Natural Moisture	21.9%		

Notes / Deviations / References:

Mal Krajan		Laboratory Manager	11/4/2024
Technical Responsibility	*Signature*	*Position*	*Date*

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Form No. TR-D4318-T89-90
Revision No.
Revision Date: 8/28/17

LIQUID LIMIT, PLASTIC LIMIT, & PLASTIC INDEX

ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐

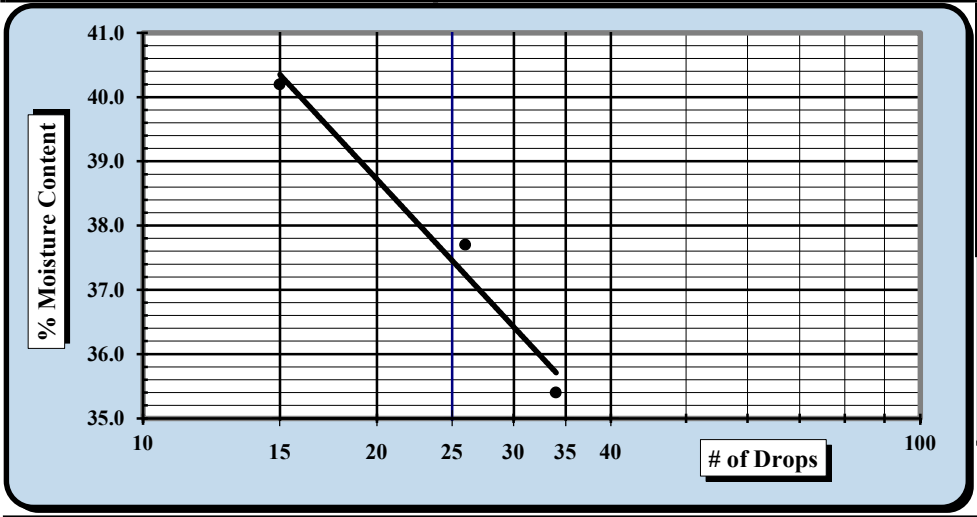
S&ME, Inc. Raleigh: 3201 Spring Forest Road, Raleigh, NC 27616

Project #:	24050612	Report Date:	10/22/2024
Project Name:	NCMA Renovations	Test Date(s)	10/18 - 10/22/24
Client Name:			
Client Address:			

Boring #:	N/A	Sample #: Bulk		Sample Date: 10/11/2024	
Location:	Site Borehole	Offset: N/A		Depth (ft): 0-5	
Sample Description:	Red-Brown Clayey SAND (SC)				

Type and Specification	*S&ME ID #*	*Cal Date:*	*Type and Specification*	*S&ME ID #*	*Cal Date:*
Balance (0.01 g)	20977	2/13/2024	Grooving tool	G-1	11/10/2023
LL Apparatus	1803	3/15/2024			
Oven	13289	8/30/2024			

Pan #		Liquid Limit						Plastic Limit		
	Tare #:									
A	Tare Weight	14.09	12.15	12.34				13.57	13.88	
B	Wet Soil Weight + A	25.41	20.80	20.75				19.79	21.26	
C	Dry Soil Weight + A	22.45	18.43	18.34				18.73	20.02	
D	Water Weight (B-C)	2.96	2.37	2.41				1.06	1.24	
E	Dry Soil Weight (C-A)	8.36	6.28	6.00				5.16	6.14	
F	% Moisture (D/E)*100	35.4%	37.7%	40.2%				20.5%	20.2%	
N	# OF DROPS	34	26	15				*Moisture Contents determined by ASTM D 2216*		
LL	LL = **F** * FACTOR									
Ave.	*Average*							**20.4%**		



One Point Liquid Limit			
N	**Factor**	**N**	**Factor**
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.99	29	1.018
24	0.995	30	1.022
25	1.000		

NP, Non-Plastic ☐

Liquid Limit	**37**
Plastic Limit	**20**
Plastic Index	**17**
Group Symbol	**SC**

Multipoint Method ☑
One-point Method ☐

Wet Preparation ☐ Dry Preparation ☐ Air Dried ☑ *Estimate the % Retained on the #40 Sieve:* 19.5%

Notes / Deviations / References:

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils

Mal Krajan		Laboratory Manager	10/22/2024
Technical Responsibility	*Signature*	*Position*	*Date*

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Form No. TR-D4318-T89-90
Revision No.
Revision Date: 8/28/17

LIQUID LIMIT, PLASTIC LIMIT, & PLASTIC INDEX

ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐

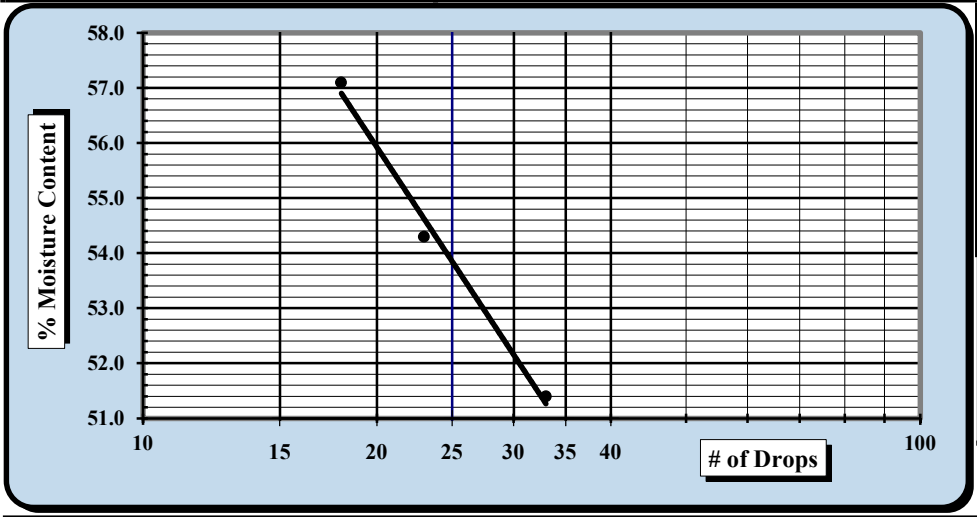
S&ME, Inc. Raleigh: 3201 Spring Forest Road, Raleigh, NC 27616

Project #:	24050612	Report Date:	11/4/2024
Project Name:	NCMA Renovations	Test Date(s)	10/28 - 11/4/24
Client Name:	Department of Natural & Cultural Resources		
Client Address:			

Boring #:	B-02	Sample #: SS-2		Sample Date: N/A	
Location:	Site-Borehole	Offset: N/A		Depth (ft): 3.5-5	
Sample Description:	Brown Sandy CLAY (CH)				

Type and Specification	*S&ME ID #*	*Cal Date:*	*Type and Specification*	*S&ME ID #*	*Cal Date:*
Balance (0.01 g)	20977	2/13/2024	Grooving tool	G-1	11/10/2023
LL Apparatus	1803	3/15/2024			
Oven	13289	8/30/2024			

Pan #		Liquid Limit						Plastic Limit		
	Tare #:									
A	Tare Weight	21.32	14.10	13.89				12.32	12.38	
B	Wet Soil Weight + A	29.57	22.45	22.42				18.59	19.06	
C	Dry Soil Weight + A	26.77	19.51	19.32				17.47	17.86	
D	Water Weight (B-C)	2.80	2.94	3.10				1.12	1.20	
E	Dry Soil Weight (C-A)	5.45	5.41	5.43				5.15	5.48	
F	% Moisture (D/E)*100	51.4%	54.3%	57.1%				21.7%	21.9%	
N	# OF DROPS	33	23	18				*Moisture Contents determined by ASTM D 2216*		
LL	LL = **F** * FACTOR									
Ave.	*Average*							**21.8%**		



One Point Liquid Limit			
N	**Factor**	**N**	**Factor**
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.99	29	1.018
24	0.995	30	1.022
25	1.000		

NP, Non-Plastic ☐

Liquid Limit	**54**
Plastic Limit	**22**
Plastic Index	**32**
Group Symbol	**CH**

Multipoint Method ☑
One-point Method ☐

Wet Preparation ☐ Dry Preparation ☐ Air Dried ☑ *Estimate the % Retained on the #40 Sieve:* 19.3%

Notes / Deviations / References:

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils

Mal Krajan		Laboratory Manager	11/4/2024
Technical Responsibility	*Signature*	*Position*	*Date*

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Important Information About Your
Geotechnical Engineering Report

Variations in subsurface conditions can be a principal cause of construction delays, cost overruns and claims. The following information is provided to assist you in understanding and managing the risk of these variations.

Geotechnical Findings Are Professional Opinions

Geotechnical engineers cannot specify material properties as other design engineers do. Geotechnical material properties have a far broader range on a given site than any manufactured construction material, and some geotechnical material properties may change over time because of exposure to air and water, or human activity.

Site exploration identifies subsurface conditions at the time of exploration and only at the points where subsurface tests are performed or samples obtained. Geotechnical engineers review field and laboratory data and then apply their judgment to render professional opinions about site subsurface conditions. Their recommendations rely upon these professional opinions. Variations in the vertical and lateral extent of subsurface materials may be encountered during construction that significantly impact construction schedules, methods and material volumes. While higher levels of subsurface exploration can mitigate the risk of encountering unanticipated subsurface conditions, no level of subsurface exploration can eliminate this risk.

Geotechnical Findings Are Professional Opinions

Professional geotechnical engineering judgment is required to develop a geotechnical exploration scope to obtain information necessary to support design and construction. A number of unique project factors are considered in developing the scope of geotechnical services, such as the exploration objective; the location, type, size and weight of the proposed structure; proposed site grades and improvements; the construction schedule and sequence; and the site geology.

Geotechnical engineers apply their experience with construction methods, subsurface conditions and exploration methods to develop the exploration scope. The scope of each exploration is unique based on available project and site information. Incomplete project information or constraints on the scope of exploration increases the risk of variations in subsurface conditions not being identified and addressed in the geotechnical report.

Services Are Performed for Specific Projects

Because the scope of each geotechnical exploration is unique, each geotechnical report is unique. Subsurface conditions are explored and recommendations are made for a specific project.

Subsurface information and recommendations may not be adequate for other uses. Changes in a proposed structure location, foundation loads, grades, schedule, etc. may require additional geotechnical exploration, analyses, and consultation. The geotechnical engineer should be consulted to determine if additional services are required in response to changes in proposed construction, location, loads, grades, schedule, etc.

Geo-Environmental Issues

The equipment, techniques, and personnel used to perform a geo-environmental study differ significantly from those used for a geotechnical exploration. Indications of environmental contamination may be encountered incidental to performance of a geotechnical exploration but go unrecognized. Determination of the presence, type or extent of environmental contamination is beyond the scope of a geotechnical exploration.

Geotechnical Recommendations Are Not Final

Recommendations are developed based on the geotechnical engineer's understanding of the proposed construction and professional opinion of site subsurface conditions. Observations and tests must be performed during construction to confirm subsurface conditions exposed by construction excavations are consistent with those assumed in development of recommendations. It is advisable to retain the geotechnical engineer that performed the exploration and developed the geotechnical recommendations to conduct tests and observations during construction. This may reduce the risk that variations in subsurface conditions will not be addressed as recommended in the geotechnical report.

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SUPPLEMENTARY GENERAL CONDITIONS

PART 1 - GENERAL

1.1 REQUIREMENTS

A. The following items are intended to modify the Second Edition January 2013 of Form OC-15CM "STANDARD FORM FOR CONSTRUCTION MANAGER-AT-RISK PROJECTS".

B. Where items of this section conflict with or are at variance with those of the General Conditions, they shall take precedence over the General Conditions and modify such requirements to the extent of such conflict or variation.

1.2 SUMMARY

A. These Supplementary General Conditions amend and supplement the Second Edition January 2013, of Form OC-15CM "STANDARD FORM FOR CONSTRUCTION MANAGER-AT-RISK PROJECTS" and other provisions of the Contract Documents as indicated below. All provisions that are not so amended or supplemented remain in full force and effect.

B. The terms used in these Supplementary General Conditions that are defined in the General Conditions have the meanings assigned to them in the General Conditions.

1.3 MODIFICATIONS TO GENERAL CONDITIONS

A. Modifications to Article 1 - Definitions:

1. Modify Paragraph b as follows: The Owner referred to is NCDNCR – North Carolina Department of Natural Resources and NCMA – North Carolina Museum of Art.
2. Modify Paragraph c as follows: The Designer referred to is HH Architecture located in Raleigh, North Carolina. Where the terms Engineer, Architect, or Architect-Engineer are used in the technical specifications, they shall mean Designer.

B. Modifications to Articles 23 - TIME OF COMPLETION, DELAYS, EXTENSION OF TIME:
1. Add new paragraph G:

The Contractor shall commence work to be performed under this agreement on a date to be specified in a written order form the designer and shall fully complete all work within **490** consecutive calendar days from, and including said date. For each day in excess of the above number of days, the Contractor shall pay to the Owner the sum of **$1,500 per day**, as liquidated damages reasonably estimated in advance to cover the losses to be incurred by the Owner by reason of failure of said Contractor to complete the work within the time specified, such time being in the essence of this contract and a material consideration thereof."

C. Modifications to Article 34 – Minimum Insurance Requirements:
1. Revise the second sentence of Paragraph c to read as follows: "This insurance shall include the interests of the Owner, the CM, and subcontractors in the work and shall insure against the perils of fire, extended coverage, and vandalism and malicious mischief and shall insure against risk of direct physical loss - (all perils)"

D. Modifications to Article 40 - Utilities, Structures, Signs:
1. Paragraph a is clarified as follows for ***payment of utility use charges***: ***The Owner will reimburse the CM for the use charges for new permanent utilities. The Owner will pay the use charges directly for utilities used for construction activities in the existing buildings. The Owner may***

recover the actual costs of metered utilities from the responsible party should delays occur in project completion.

2. Add the following Paragraph l: The Contractor is responsible for all utility, structure, and sign requirements and costs as specified in section 015000 - Temporary Facilities and Controls.

E. Modifications to Article 42 – Guarantee

1. Add the following new paragraph e.:

e. Where specifications reference commencement of guarantees and warranties at the "Substantial Completion" date, this shall begin instead at the "Final Acceptance" date in accordance with Article 25 of the General Conditions. In the event of partial utilization of the project by the Owner for Beneficial Occupancy, the commencement of guarantees and warranties for equipment under Article 24, paragraph b. 1 of the General Conditions shall begin at the date of acceptance for Beneficial Occupancy.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 011000 - SUMMARY

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Project information.
   2. Work covered by Contract Documents.
   3. Work by Owner.
   4. Future Work.
   5. Owner-furnished products.
   6. Access to site.
   7. Work restrictions.
   8. Specification and Drawing conventions.

B. Related Requirements:
   1. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.3 PROJECT INFORMATION

A. Project Identification: NC Museum of Art East Building and Museum Park Improvements.
   1. Project Location: 2110 Blue Ridge Road, Raleigh, NC 27607.

B. Owner: North Carolina Department of Natural and Cultural Resources.
   1. Owner's Representative: Erin Lawrence, 919-814-6613; Tony Romaine, 919-814-6614.

C. Architect: HH Architecture, P.O. Box 18808, Raleigh, NC 27609.

D. Architect's Consultants: Architect has retained the following design professionals who have prepared designated portions of the Contract Documents:
   1. Mechanical, Electrical, and Plumbing Engineer: Salas OBrien, 702 Oberlin Road, Suite 300, Raleigh, NC 27605.
   2. Structural Engineer: Lynch Mykins, 301 N West Street, Suite 105, Raleigh, NC 27616.
   3. Civil Engineer: Kimley-Horn, 421 Fayetteville Street, Suite 600, Raleigh, NC 27601.
   4. Landscape Architect: Design Workshop, 621 Hillsborough St. Suite 202 Raleigh, NC 27603.
   5. Design Architect: EskewDumezRipple, 1701 Rhode Island Ave NW, Washington DC, 20036.

6. Art Conservation Architect: Samuel Anderson Architects, 307 West 38 St, Suite 1901, New York NY 10018.
7. Lighting Designer: Linnaea Tillett Lighting Design Associates, Inc. 11 Hanover Square, 17th Floor, New York, NY 10005.

E. Other Owner Consultants: Owner has retained the following design professionals who have prepared designated portions of the Contract Documents:
1. Geotechnical: S&ME, Inc. 3201 Spring Forest Road, Raleigh, North Carolina 27616.

1.4 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of Project is defined by the Contract Documents and consists of the following:
1. Art Conservation: Renovation of East Building Level B Conservation Studios. Renovation & Addition at East Building Level A into a public-facing conservation studio and gallery space.
2. Park Amphitheater Upgrades: Renovation of existing amphitheater including replacement of existing seating, addition of ADA seating & pathways, bird mitigation and deferred maintenance, including paint and roof replacement.
3. East Building Park Entrance: Renovation of existing façade at the Level C entrance to the East Building and the addition of an interior vestibule. Renovation & reconfiguration of the existing kitchen space at Level C.
4. Community Arts & Education Center: Interior renovation of the existing Level C space into a family friendly space for art education and youth focused events.
5. Terrace & Green Open-Air Event Pavilion: Addition of a covered and open structure at the Level C Park Entry to the East Building.

B. Type of Contract:
1. Project will be constructed under a single prime contract in accordance with the State of North Carolina’s requirements.

1.5 WORK UNDER SEPARATE CONTRACTS

A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying Work under this Contract or other contracts. Coordinate the Work of this Contract with work performed under separate contracts.

1.6 FUTURE WORK

A. The Contract Documents include requirements that will allow Owner to carry out future work following completion of this Project; provide for the following future work:
1. Furniture Installation.

1.7 OWNER-FURNISHED PRODUCTS

A. Owner will furnish products indicated. The Work includes receiving, unloading, handling, storing, protecting, and installing Owner-furnished products and making building services connections.

B. Owner-Furnished Products:
   1. Security cameras.
   2. Furniture.
   3. Select Lab Equipment.
   4. Card Access Readers.
   5. Audio Visual Equipment.

1.8 ACCESS TO SITE

A. General: Each Contractor shall have full use of Project site for construction operations during construction period. Contractor's use of Project site is limited only by Owner's right to perform work or to retain other contractors on portions of Project.

B. Use of Site: Limit use of Project site to areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.
   1. Limits: Confine construction operations to Area of Disturbance as defined on drawings.

1.9 WORK RESTRICTIONS

A. Work Restrictions, General: Comply with restrictions on construction operations.
   1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.

B. On-Site Work Hours: Limit work in the existing building to normal business working hours of 7:00 a.m. to 6:00 p.m., Monday through Friday, unless otherwise indicated.

C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner (North Carolina Museum of Art) unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:
   1. Coordinate disruptive actions with Owner.

D. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy (North Carolina Museum of Art) with Owner.
   1. Coordinate disruptive actions with Owner.

E. Site restrictions: See project documents for site disruptions and site work areas. All campus traffic patterns must be maintained as documented. All disruptions must be pre-approved by the Owner.

F. Restricted Substances: Use of tobacco products and other controlled substances on Project site is not permitted.

G. Employee Identification: Provide identification tags for Contractor personnel working on Project site. Require personnel to use identification tags at all times.

H. Employee Screening: Comply with Owner's requirements for drug and background screening of Contractor personnel working on Project site.
   1. Maintain list of approved screened personnel with Owner's representative.

1.10 SPECIFICATION AND DRAWING CONVENTIONS

A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
   1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
   2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.

B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
   1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
   2. Abbreviations: Materials and products are identified by abbreviations published as part of the U.S. National CAD Standard and scheduled on Drawings.
   3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 011000

SECTION 012300 - ALTERNATES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for alternates.

1.2 DEFINITIONS

A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
   1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
   2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.

1.3 PROCEDURES

A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
   1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.

B. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated revisions to alternates.

C. Execute accepted alternates under the same conditions as other work of the Contract.

D. Schedule: A schedule of alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 SCHEDULE OF ALTERNATES

A. Alternate No. 1: BAR FITOUT.
   1. Base Bid: Provide bar area with floor tile and new walls as indicated on the drawings.
   2. Alternate: In addition to the base bid, provide bar countertop, casework, wall tile and sink as indicated on the drawings.

B. Alternate No. 2: KITCHEN EQUIPMENT.
   1. Base Bid: Relocate existing fixtures as indicated on the drawings.
   2. Alternate: In lieu of the base bid, provide new combi oven, griddle, fryer, burner char broiler and oven as indicated on the drawings.

C. Alternate No. 3: CONSERVATION OFFICE.
   1. Base Bid: Provide new room as indicated on the drawings.
   2. Alternate: In addition to the base bid, provide cubicles and upper cabinets as indicated on the drawings.

D. Alternate No. 4: CONSERVATION STUDIO.
   1. Base Bid: Provide conservation studio room as indicated on the drawings.
   2. Alternate: In addition to the base bid, provide casework as indicated on the drawings.

E. Alternate No. 5: CONSERVATION ENGAGMENT.
   1. Base Bid: Provide conservation engagement room as indicated on the drawings.
   2. Alternate: In addition to the base bid, provide countertops, cabinets, material storage cabinet, display cabinet and worktable as indicated on the drawings.

F. Alternate No. 6: PAPER TREATMENT SYSTEM.
   1. Base Bid: no work.
   2. Alternate: In lieu of the base bid, provide paper treatment sink, curtain, bleaching lights and deionized water system as indicated on the drawings.

G. Alternate No. 7: VERTICAL PAINT STORAGE AND TABORETS.
   1. Base Bid: no work.
   2. Alternate: In lieu of the base bid, provide vertical paint storage systems and taborets at Level A and Level B as indicated on the drawings.

H. Alternate No. 8: TIME BASED MEDIA ROOM.
   1. Base Bid: Provide time-based media room as indicated on the drawings.
   2. Alternate: In addition to the base bid, provide casework as indicated on the drawings.

I. Alternate No. 9: MEETING ROOM.
   1. Base Bid: Provide Meeting room as indicated on the drawings.
   2. Alternate: In addition to the base bid, provide casework and custom table as indicated on the drawings.

J. Preferred Brand Alternate A: Indicate cost increase to provide and install owner-preferred mechanical controls as selected by a single-source manufacturer. The product provided must be a Trane product meeting the requirements of the specifications Division 23 “Direct Digital Control Systems for HVAC.”.
   1. Base Bid: Provide mechanical controls as specified in Division 23.
   2. Alternate: In lieu of the base bid, mechanical controls by Trane.

END OF SECTION 012300

SECTION 012500 - SUBSTITUTION PROCEDURES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for substitutions.

B. Related Requirements:
   1. Section 016000 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.3 DEFINITIONS

A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
   1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
   2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

1.4 ACTION SUBMITTALS

A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
   1. Substitution Request Form: Use facsimile of form provided in Project Manual.
   2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
      a. Statement indicating why specified product or fabrication or installation method cannot be provided, if applicable.
      b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
      c. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size,

durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.

d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
e. Samples, where applicable or requested.
f. Certificates and qualification data, where applicable or requested.
g. List of similar installations for completed projects, with project names and addresses as well as names and addresses of architects and owners.
h. Material test reports from a qualified testing agency, indicating and interpreting test results for compliance with requirements indicated.
i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.
j. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
k. Cost information, including a proposal of change, if any, in the Contract Sum.
l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
   a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
   b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.5 QUALITY ASSURANCE

A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.6 PROCEDURES

A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

1.7 SUBSTITUTIONS

A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
   1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
      a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
      b. Substitution request is fully documented and properly submitted.
      c. Requested substitution will not adversely affect Contractor's construction schedule.
      d. Requested substitution has received necessary approvals of authorities having jurisdiction.
      e. Requested substitution is compatible with other portions of the Work.
      f. Requested substitution has been coordinated with other portions of the Work.
      g. Requested substitution provides specified warranty.
      h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

B. Substitutions for Convenience: Not allowed unless otherwise indicated.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 012500

SECTION 012600 - CONTRACT MODIFICATION PROCEDURES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for handling and processing Contract modifications.

B. Related Requirements:
   1. Section 012500 "Substitution Procedures" for administrative procedures for handling requests for substitutions made after the Contract award.

1.3 MINOR CHANGES IN THE WORK

A. Architect will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on form included in Project Manual.

1.4 PROPOSAL REQUESTS

A. Owner-Initiated Proposal Requests: Contractor will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
   1. Work Change Proposal Requests issued by Contractor are not instructions either to stop work in progress or to execute the proposed change.
   2. Within time specified in Proposal Request or 20 days, when not otherwise specified, after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
      a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
      b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
      c. Include costs of labor and supervision directly attributable to the change.
      d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

e. Quotation Form: Use forms provided by Owner.

B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to the Architect.
1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
4. Include costs of labor and supervision directly attributable to the change.
5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
6. Comply with requirements in Section 012500 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.
7. Proposal Request Form: Use form provided by Owner.

1.5 CHANGE ORDER PROCEDURES

A. On Owner's approval of a Work Change Proposal Request, Architect will issue a Change Order for approval by Owner and Contractor on State Construction Interscope System.

1.6 CONSTRUCTION CHANGE DIRECTIVE

A. Construction Change Directive: Architect may issue a Construction Change Directive on form included in Project Manual. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.

B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.
1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 012600

State Construction Office

Field Order # _____

Project: _____ Location: _____ Project ID: _____

Description of Change: _____

_____

_____

Justification of Change: _____

_____

_____

CONTRACTOR:
A total cost change not to exceed a lump sum cost is $ _____ or a unit cost of _____ extended using estimated quantities to not exceed is $ _____. The contractor will need a maximum number of _____ days time extension to the contract. The actual cost, not to exceed stated cost, shall be based on a realistic estimate based on current acceptable market values submitted with change order for approval by designer, owner, and State Construction Office.

DESIGNER:
The quoted price and need for the change are in the best interests of the owner to have the work accomplished. A formal change order will be prepared for contractor's signature within seven (7) days.

OWNING AGENCY:
The owning agency agrees to the change as being in the owner's best interest. Adequate funds are available to pay the cost for the change.

STATE CONSTRUCTION OFFICE:
The State Construction Office approves the request for the change.

SIGNATURES:

_____ _____
Contractor: Date:

_____ _____
Designer: Date:

_____ _____
Owning Agency: Date:

_____ _____

State Construction Office: Date:

(8/26/99)

HH ARCHITECTURE

1100 DRESSER COURT RALEIGH, NC 27609
919 828-2301 TEL 919 828-2303 FAX HH-ARCH.COM

Request for Proposal

Project: **NC Museum of Art East Building and Museum Park Improvements**

Proposal Request #:

HH # 22-028
SCO # 22-25283-02A

Owner: NCDNCR

Date of Issuance:

To:

Contract For:

Contract Dated:

Please submit an itemized proposal for changes in the Contract Sum and Contract Time for proposed modifications to the Contract Documents described herein. Submit proposal within 7 days or notify the Architect in writing of the date on which you anticipate submitting your proposal.

THIS IS NOT A CHANGE ORDER, CONSTRUCTION CHANGE DIRECTIVE OR A DIRECTION TO PROCEED WITH THE WORK DESCRIBED IN THE PROPOSED MODIFICATIONS.

Description:

All changes in specified items must be submitted to the designer for review and approval.

Attachments:

Requested By:

HH ARCHITECTURE

1100 DRESSER COURT RALEIGH, NC 27609
919 828-2301 TEL 919 828-2303 FAX HH-ARCH.COM

Construction Change Directive

Project: **NC Museum of Art East Building and Museum Park Improvements**
Owner: NCDNCR

HH # 22-028 Date of Issuance:
SCO # 22-25283-02A

To:

Please submit an itemized proposal for changes in the Contract Sum and Contract Time for proposed modifications to the Contract Documents described herein. Submit a change order request upon completion of the work indicating actual cost of the work described in the directive.

Description:

Attachments:

Requested By:

SECTION 012900 - PAYMENT PROCEDURES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.

B. Related Requirements:
   1. Section 012600 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
   2. Section 013200 "Construction Progress Documentation" for administrative requirements governing the preparation and submittal of the Contractor's construction schedule.

1.3 DEFINITIONS

A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

1.4 SCHEDULE OF VALUES

A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.
   1. Coordinate line items in the schedule of values with items required to be indicated as separate activities in Contractor's construction schedule.
   2. Submit the schedule of values to Architect through the Contractor at earliest possible date, but no later than seven days before the date scheduled for submittal of initial Applications for Payment.
   3. Subschedules for Phased Work: Where the Work is separated into phases requiring separately phased payments, provide subschedules showing values coordinated with each phase of payment.
   4. Subschedules for Separate Elements of Work: Where the Contractor's construction schedule defines separate elements of the Work, provide subschedules showing values coordinated with each element.
   5. Subschedules for Separate Design Contracts: Where the Owner has retained design professionals under separate contracts who will each provide certification of payment requests, provide subschedules showing values coordinated with the scope of each design

services contract, as described in Section 011000 "Summary."

B. Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification Section.
   1. Identification: Include the following Project identification on the schedule of values:
      a. Project name and location.
      b. Name of Architect.
      c. Architect's Project number.
      d. Contractor's name and address.
      e. Date of submittal.
   2. Arrange schedule of values consistent with format of AIA Document G703.
   3. Arrange the schedule of values in tabular form, with separate columns to indicate the following for each item listed:
      a. Related Specification Section or Division.
      b. Description of the Work.
      c. Name of subcontractor.
      d. Name of manufacturer or fabricator.
      e. Name of supplier.
      f. Change Orders (numbers) that affect value.
      g. Dollar value of the following, as a percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent. Round dollar amounts to whole dollars, with total equal to Contract Sum.
         1) Labor.
         2) Materials.
         3) Equipment.
   4. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.
   5. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
      a. Differentiate between items stored on-site and items stored off-site.
   6. Allowances: Provide a separate line item in the schedule of values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.
   7. Purchase Contracts: Provide a separate line item in the schedule of values for each purchase contract. Show line-item value of purchase contract. Indicate Owner payments or deposits, if any, and balance to be paid by Contractor.
   8. Overhead Costs: Include total cost and proportionate share of general overhead and profit for each line item.
   9. Overhead Costs: Show cost of temporary facilities and other major cost items that are not direct cost of actual work-in-place as separate line items.
   10. Closeout Costs. Include separate line items under Contractor and principal subcontracts for Project closeout requirements in an amount totaling [five] percent of the Contract Sum and subcontract amount.
   11. Schedule of Values Revisions: Revise the schedule of values when Change Orders or Construction Change Directives result in a change in the Contract Sum. Include at least one separate line item for each Change Order and Construction Change Directive.

1.5 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments as certified by Architect and the Contractor and paid for by Owner.

B. Payment Application Times: The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.

C. Application for Payment Forms: Use AIA Document G732 and AIA Document G703 as form for Applications for Payment.
   1. Other Application for Payment forms proposed by the Contractor shall be acceptable to the Contractor and Owner. Submit forms for approval with initial submittal of schedule of values.

D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. The Contractor will return incomplete applications without action.
   1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
   2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
   3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
   4. Indicate separate amounts for work being carried out under Owner-requested project acceleration.

E. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.
   1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment for stored materials.
   2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
   3. Provide summary documentation for stored materials indicating the following:
      a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
      b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
      c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

F. Transmittal: Submit electronic copies of each Application for Payment to The Contractor by a method ensuring receipt within 24 hours. Electronic copy shall include waivers of lien and similar attachments if required.
   1. Transmit each copy with a transmittal form listing attachments and recording appropriate

information about application.

G. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from entities lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.
   1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
   2. When an application shows completion of an item, submit conditional final or full waivers.
   3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
   4. Submit final Application for Payment with or preceded by conditional final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.
   5. Waiver Forms: Submit executed waivers of lien on forms acceptable to Owner.

H. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
   1. List of subcontractors.
   2. Schedule of values.
   3. Contractor's construction schedule (preliminary if not final).
   4. Combined Contractor's construction schedule (preliminary if not final) incorporating Work of multiple contracts, with indication of acceptance of schedule by each Contractor.
   5. Products list (preliminary if not final).
   6. Sustainable design action plans, including preliminary project materials cost data.
   7. Schedule of unit prices.
   8. Submittal schedule (preliminary if not final).
   9. List of Contractor's staff assignments.
   10. List of Contractor's principal consultants.
   11. Copies of building permits.
   12. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
   13. Initial progress report.
   14. Report of preconstruction conference.
   15. Certificates of insurance and insurance policies.
   16. Performance and payment bonds.
   17. Data needed to acquire Owner's insurance.

I. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
   1. Evidence of completion of Project closeout requirements.
   2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
   3. Updated final statement, accounting for final changes to the Contract Sum.
   4. AIA Document G706.
   5. AIA Document G706A.
   6. AIA Document G707.
   7. Evidence that claims have been settled.

8. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Final Acceptance or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
9. Final liquidated damages settlement statement.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 012900

SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
   1. General coordination procedures.
   2. Coordination drawings.
   3. RFIs.
   4. Digital project management procedures.
   5. Web-based Project management software package.
   6. Project meetings.

B. Each contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific contractor.

C. Related Requirements:
   1. Section 013200 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
   2. Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
   3. Section 017700 "Closeout Procedures" for coordinating closeout of the Contract.

1.3 DEFINITIONS

A. RFI: Request for Information. Request from Owner, Architect, or Contractor seeking information required by or clarifications of the Contract Documents.

1.4 INFORMATIONAL SUBMITTALS

A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
   1. Name, address, telephone number, and email address of entity performing subcontract or supplying products.
   2. Number and title of related Specification Section(s) covered by subcontract.
   3. Drawing number and detail references, as appropriate, covered by subcontract.

B. Key Personnel Names: Within 14 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and cellular telephone numbers and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.
   1. Post copies of list in project meeting room, in temporary field office, and in prominent location in built facility. Keep list current at all times.

1.5 GENERAL COORDINATION PROCEDURES

A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections that depend on each other for proper installation, connection, and operation.
   1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
   2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
   3. Make adequate provisions to accommodate items scheduled for later installation.

B. Coordination: Each contractor shall coordinate its construction operations with those of other contractors and entities to ensure efficient and orderly installation of each part of the Work. Each contractor shall coordinate its own operations with operations included in different Sections that depend on each other for proper installation, connection, and operation.
   1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
   2. Coordinate installation of different components with other contractors to ensure maximum performance and accessibility for required maintenance, service, and repair.
   3. Make adequate provisions to accommodate items scheduled for later installation.

C. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
   1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.

D. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
   1. Preparation of Contractor's construction schedule.
   2. Preparation of the schedule of values.
   3. Installation and removal of temporary facilities and controls.
   4. Delivery and processing of submittals.
   5. Progress meetings.
   6. Preinstallation conferences.
   7. Project closeout activities.

8. Startup and adjustment of systems.

1.6 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely indicated on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
   1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
      a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
      b. Coordinate the addition of trade-specific information to coordination drawings in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
      c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
      d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
      e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
      f. Indicate required installation sequences.
      g. Indicate dimensions shown on Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternative sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

B. Coordination Drawing Organization: Organize coordination drawings as follows:
   1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
   2. Plenum Space: Indicate sub-framing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within plenums to accommodate layout of light fixtures and other components indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
   3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
   4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
   5. Mechanical and Plumbing Work: Show the following:
      a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.

b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
c. Fire-rated enclosures around ductwork.

6. Electrical Work: Show the following:
   a. Runs of vertical and horizontal conduit 1-1/4 inches (32 mm) in diameter and larger.
   b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire-alarm locations.
   c. Panel board, switch board, switchgear, transformer, busway, generator, and motor-control center locations.
   d. Location of pull boxes and junction boxes, dimensioned from column center lines.
7. Review: Architect will review coordination drawings to confirm that in general the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect will so inform Contractor, who shall make suitable modifications and resubmit.
8. Coordination Drawing Prints: Prepare coordination drawing prints according to requirements in Section 013300 "Submittal Procedures."

1.7 REQUEST FOR INFORMATION (RFI)

A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
   1. Architect will return without response those RFIs submitted to Architect by other entities controlled by Contractor.
   2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
   1. Project name.
   2. Project number.
   3. Date.
   4. Name of Contractor.
   5. Name of Architect.
   6. RFI number, numbered sequentially.
   7. RFI subject.
   8. Specification Section number and title and related paragraphs, as appropriate.
   9. Drawing number and detail references, as appropriate.
   10. Field dimensions and conditions, as appropriate.
   11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
   12. Contractor's signature.
   13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
       a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

C. RFI Forms: AIA Document G716.
   1. Attachments shall be electronic files in PDF format.

D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow seven working days for Architect's response for each RFI. RFIs received by Architect after 1:00 p.m. will be considered as received the following working day.
   1. The following Contractor-generated RFIs will be returned without action:
      a. Requests for approval of submittals.
      b. Requests for approval of substitutions.
      c. Requests for approval of Contractor's means and methods.
      d. Requests for coordination information already indicated in the Contract Documents.
      e. Requests for adjustments in the Contract Time or the Contract Sum.
      f. Requests for interpretation of Architect's actions on submittals.
      g. Incomplete RFIs or inaccurately prepared RFIs.
   2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt by Architect of additional information.
   3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."
      a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within 10 days of receipt of the RFI response.

E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Use software log that is part of web-based Project software.
   1. Project name.
   2. Name and address of Contractor.
   3. Name and address of Architect.
   4. RFI number including RFIs that were returned without action or withdrawn.
   5. RFI description.
   6. Date the RFI was submitted.
   7. Date Architect's response was received.
   8. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
   9. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

F. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within seven days if Contractor disagrees with response.

1.8 DIGITAL PROJECT MANAGEMENT PROCEDURES

A. Architect’s Data Files Not Available: Architect will not provide Architect’s BIM model digital data files for Contractor’s use during construction.

B. Use of Architect’s Digital Data Files: Digital data file of Architect’s CAD drawings will be provided by Architect for Contractor's use during construction.
   1. Digital data files may be used by Contractor in preparing coordination drawings, Shop Drawings, and Project Record Drawings.
   2. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Contract Drawings.
   3. Contractor shall execute a data licensing agreement in the form of AIA Document C106 Digital Data Licensing Agreement.
      a. Subcontractors and other parties granted access by Contractor to Architect's digital data files shall execute a data licensing agreement in the form of AIA Document C106.
   4. The following digital data files will be furnished for each appropriate discipline:
      a. Floor plans.
      b. Reflected ceiling plans.

C. Web-Based Project Management Software Package: Provide, administer, and use web-based Project management software package for purposes of hosting and managing Project communication and documentation until Final Completion.
   1. Web-based Project management software includes, at a minimum, the following features:
      a. Compilation of Project data, including Contractor, subcontractors, Architect, Architect's consultants, Owner, and other entities involved in Project. Include names of individuals and contact information.
      b. Access control for each entity for each workflow process, to determine entity's digital rights to create, modify, view, and print documents.
      c. Document workflow planning, allowing customization of workflow between project entities.
      d. Creation, logging, tracking, and notification for Project communications required in other Specification Sections, including, but not limited to, RFIs, submittals, Minor Changes in the Work, Construction Change Directives, and Change Orders.
      e. Track status of each Project communication in real time, and log time and date when responses are provided.
      f. Procedures for handling PDFs or similar file formats, allowing markups by each entity. Provide security features to lock markups against changes once submitted.
      g. Processing and tracking of payment applications.
      h. Processing and tracking of contract modifications.
      i. Creating and distributing meeting minutes.
      j. Document management for Drawings, Specifications, and coordination drawings, including revision control.
      k. Management of construction progress photographs.
      l. Mobile device compatibility, including smartphones and tablets.
   2. Provide up to seven Project management software user licenses for use of Owner, Architect, and Architect's consultants.
   3. At completion of Project, provide digital archive in format that is readable by common desktop software applications in format acceptable to Architect. Provide data in locked format to prevent further changes.
   4. HYPERLINK "http://www.specagent.com/Lookup?ulid=13860"Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Corecon Technologies, Inc.
      b. Newforma, Inc.

c. Procore Technologies, Inc.

D. PDF Document Preparation: Where PDFs are required to be submitted to Architect, prepare as follows:
1. Assemble complete submittal package into a single indexed file, incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
2. Name file with submittal number or other unique identifier, including revision identifier.
3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

1.9 PROJECT MEETINGS

A. General: Architect to schedule and conduct meetings and conferences at Project site unless otherwise indicated.
1. Attendees: Architect to inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times a minimum of 10 working days prior to meeting.
2. Agenda: Architect to prepare the meeting agenda. Distribute the agenda to all invited attendees.
3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.

B. Preconstruction Conference: Architect will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than 15 days after execution of the Agreement.
1. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Discuss items of significance that could affect progress, including the following:
a. Responsibilities and personnel assignments.
b. Tentative construction schedule.
c. Phasing.
d. Critical work sequencing and long lead items.
e. Designation of key personnel and their duties.
f. Lines of communications.
g. Procedures for processing field decisions and Change Orders.
h. Procedures for RFIs.
i. Procedures for testing and inspecting.
j. Procedures for processing Applications for Payment.
k. Submittal procedures.
l. Preparation of Record Documents.
m. Use of the premises and existing building.
n. Work restrictions.
o. Working hours.
p. Owner's occupancy requirements.

q. Responsibility for temporary facilities and controls.
r. Procedures for moisture and mold control.
s. Procedures for disruptions and shutdowns.
t. Construction waste management and recycling.
u. Parking availability.
v. Office, work, and storage areas.
w. Equipment deliveries and priorities.
x. First aid.
y. Security.
z. Progress cleaning.

3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.

C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity when required by other sections and when required for coordination with other construction.
1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect of scheduled meeting dates.
2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
a. Contract Documents.
b. Options.
c. Related RFIs.
d. Related Change Orders.
e. Purchases.
f. Deliveries.
g. Submittals.
h. Review of mockups.
i. Possible conflicts.
j. Compatibility requirements.
k. Time schedules.
l. Weather limitations.
m. Manufacturer's written instructions.
n. Warranty requirements.
o. Compatibility of materials.
p. Acceptability of substrates.
q. Temporary facilities and controls.
r. Space and access limitations.
s. Regulations of authorities having jurisdiction.
t. Testing and inspecting requirements.
u. Installation procedures.
v. Coordination with other work.
w. Required performance results.
x. Protection of adjacent work.
y. Protection of construction and personnel.
3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.

4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

D. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to Owner and Architect, but no later than 90 days prior to the scheduled date of Final Acceptance.
   1. Conduct the conference to review requirements and responsibilities related to Project closeout.
   2. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
   3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:
      a. Preparation of Record Documents.
      b. Procedures required prior to inspection for Final Acceptance and for final inspection for acceptance.
      c. Procedures for completing and archiving web-based Project software site data files.
      d. Submittal of written warranties.
      e. Requirements for completing sustainable design documentation.
      f. Requirements for preparing operations and maintenance data.
      g. Requirements for delivery of material samples, attic stock, and spare parts.
      h. Requirements for demonstration and training.
      i. Preparation of Contractor's punch list.
      j. Procedures for processing Applications for Payment at Final Acceptance and for final payment.
      k. Submittal procedures.
      l. Owner's partial occupancy requirements.
      m. Installation of Owner's furniture, fixtures, and equipment.
      n. Responsibility for removing temporary facilities and controls.
   4. Minutes: Entity conducting meeting will record and distribute meeting minutes.

E. Progress Meetings: Conduct progress meetings at monthly intervals.
   1. Coordinate dates of meetings with preparation of payment requests.
   2. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
   3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
      a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so.

Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

1) Review schedule for next period.

b. Review present and future needs of each entity present, including the following:
   1) Interface requirements.
   2) Sequence of operations.
   3) Status of submittals.
   4) Status of sustainable design documentation.
   5) Deliveries.
   6) Off-site fabrication.
   7) Access.
   8) Site use.
   9) Temporary facilities and controls.
   10) Progress cleaning.
   11) Quality and work standards.
   12) Status of correction of deficient items.
   13) Field observations.
   14) Status of RFIs.
   15) Status of Proposal Requests.
   16) Pending changes.
   17) Status of Change Orders.
   18) Pending claims and disputes.
   19) Documentation of information for payment requests.

4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
   a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 013100

SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
   1. Startup construction schedule.
   2. Contractor's Construction Schedule.
   3. Construction schedule updating reports.
   4. Daily construction reports.
   5. Material location reports.
   6. Site condition reports.
   7. Unusual event reports.

1.3 DEFINITIONS

A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction Project. Activities included in a construction schedule consume time and resources.
   1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
   2. Predecessor Activity: An activity that precedes another activity in the network.
   3. Successor Activity: An activity that follows another activity in the network.

B. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.

C. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.

D. Event: The starting or ending point of an activity.

E. Float: The measure of leeway in starting and completing an activity.
   1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.

2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.

F. Resource Loading: The allocation of manpower and equipment necessary for completing an activity as scheduled.

1.4 INFORMATIONAL SUBMITTALS

A. Format for Submittals: Submit required submittals in the following format:
1. Working electronic copy of schedule file, where indicated.
2. PDF file.
3. Two paper copies, of sufficient size to display entire period or schedule, as required.

B. Startup construction schedule.
1. Submittal of cost-loaded, startup construction schedule will not constitute approval of schedule of values for cost-loaded activities.

C. Startup Network Diagram: Of size required to display entire network for entire construction period. Show logic ties for activities.

D. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
1. Submit a working digital copy of schedule, using software indicated, and labeled to comply with requirements for submittals.

E. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.
1. Activity Report: List of activities sorted by activity number and then early start date, or actual start date if known.
2. Logic Report: List of preceding and succeeding activities for each activity, sorted in ascending order by activity number and then by early start date, or actual start date if known.
3. Total Float Report: List of activities sorted in ascending order of total float.
4. Earnings Report: Compilation of Contractor's total earnings from the Notice to Proceed until most recent Application for Payment.

F. Construction Schedule Updating Reports: Submit with Applications for Payment.

G. Daily Construction Reports: Submit at monthly intervals.

H. Material Location Reports: Submit at monthly intervals.

I. Site Condition Reports: Submit at time of discovery of differing conditions.

J. Unusual Event Reports: Submit at time of unusual event.

K. Qualification Data: For scheduling consultant.

1.5 QUALITY ASSURANCE

A. Scheduling Consultant Qualifications: An experienced specialist in CPM scheduling and reporting, with capability of producing CPM reports and diagrams within 24 hours of Architect's request.

1.6 COORDINATION

A. Coordinate Contractor's Construction Schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests, and other required schedules and reports.
   1. Secure time commitments for performing critical elements of the Work from entities involved.
   2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

1.7 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

A. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.

B. Time Frame: Extend schedule from date established for commencement of the Work to date of final completion.
   1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

C. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule and show how the sequence of the Work is affected.
   1. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
   2. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Section 011000 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
   3. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Section 011000 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
   4. Work Restrictions: Show the effect of the following items on the schedule:
      a. Coordination with existing construction.
      b. Limitations of continued occupancies.
      c. Uninterruptible services.
      d. Partial (Beneficial) occupancy before Final Completion.
      e. Use-of-premises restrictions.
      f. Provisions for future construction.
      g. Seasonal variations.

h. Environmental control.

5. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
   a. Subcontract awards.
   b. Submittals.
   c. Purchases.
   d. Mockups.
   e. Fabrication.
   f. Sample testing.
   g. Deliveries.
   h. Installation.
   i. Tests and inspections.
   j. Adjusting.
   k. Curing.
   l. Startup and placement into final use and operation.
6. Construction Areas: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
   a. Structural completion.
   b. Temporary enclosure and space conditioning.
   c. Permanent space enclosure.
   d. Completion of mechanical installation.
   e. Completion of electrical installation.
   f. Final Completion.

D. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:
   1. Unresolved issues.
   2. Unanswered Requests for Information.
   3. Rejected or unreturned submittals.
   4. Notations on returned submittals.
   5. Pending modifications affecting the Work and the Contract Time.

E. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
   1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
   2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
   3. As the Work progresses, indicate final completion percentage for each activity.

F. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, equipment required to achieve compliance, and date by which recovery will be accomplished.

G. Distribution: Distribute copies of approved schedule to Architect, Contractor, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
   1. Post copies in Project meeting rooms and temporary field offices.
   2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

1.8 STARTUP CONSTRUCTION SCHEDULE

A. Gantt-Chart Schedule: Submit startup, horizontal, Gantt-chart-type construction schedule within seven days of date established for commencement of the Work.

B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first 90 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

1.9 GANTT-CHART SCHEDULE REQUIREMENTS

A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's Construction Schedule within 30 days of date established for commencement of the Work.
   1. Base schedule on the startup construction schedule and additional information received since the start of Project.

B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.
   1. For construction activities that require three months or longer to complete, indicate an estimated completion percentage in 10 percent increments within time bar.

1.10 CPM SCHEDULE REQUIREMENTS

A. General: Prepare network diagrams using AON (activity-on-node) format.

B. Startup Network Diagram: Submit diagram within 14 days of date established for commencement of the Work. Outline significant construction activities for the first 90 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

C. CPM Schedule: Prepare Contractor's Construction Schedule using a time-scaled CPM network analysis diagram for the Work.
   1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 60 days after date established for commencement of the Work.
      a. Failure to include any work item required for performance of this Contract shall not excuse Contractor from completing all work within applicable completion dates.

2. Conduct educational workshops to train and inform key Project personnel, including subcontractors' personnel, in proper methods of providing data and using CPM schedule information.
3. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
4. Use "one workday" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule to coordinate with the Contract Time.

D. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the startup network diagram, prepare a skeleton network to identify probable critical paths.
1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:
    a. Preparation and processing of submittals.
    b. Mobilization and demobilization.
    c. Purchase of materials.
    d. Delivery.
    e. Fabrication.
    f. Utility interruptions.
    g. Installation.
    h. Work by Owner that may affect or be affected by Contractor's activities.
    i. Testing and inspection.
    j. Punch list and final completion.
    k. Activities occurring following final completion.
2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.
3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.
    a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.

E. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment to demonstrate the effect of the proposed change on the overall Project schedule.

F. Initial Issue of Schedule: Prepare initial network diagram from a sorted activity list indicating straight "early start-total float." Identify critical activities. Prepare tabulated reports showing the following:
1. Contractor or subcontractor and the Work or activity.
2. Description of activity.
3. Main events of activity.
4. Immediate preceding and succeeding activities.
5. Early and late start dates.
6. Early and late finish dates.

7. Activity duration in workdays.
8. Total float or slack time.
9. Average size of workforce.
10. Dollar value of activity (coordinated with the schedule of values).

G. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:
   1. Identification of activities that have changed.
   2. Changes in early and late start dates.
   3. Changes in early and late finish dates.
   4. Changes in activity durations in workdays.
   5. Changes in the critical path.
   6. Changes in total float or slack time.
   7. Changes in the Contract Time.

H. Value Summaries: Prepare two cumulative value lists, sorted by finish dates.
   1. In first list, tabulate activity number, early finish date, dollar value, and cumulative dollar value.
   2. In second list, tabulate activity number, late finish date, dollar value, and cumulative dollar value.
   3. In subsequent issues of both lists, substitute actual finish dates for activities completed as of list date.
   4. Prepare list for ease of comparison with payment requests; coordinate timing with progress meetings.
      a. In both value summary lists, tabulate "actual percent complete" and "cumulative value completed" with total at bottom.
      b. Submit value summary printouts one week before each regularly scheduled progress meeting.

1.11 REPORTS

A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
   1. List of subcontractors at Project site.
   2. List of separate contractors at Project site.
   3. Approximate count of personnel at Project site.
   4. Equipment at Project site.
   5. Material deliveries.
   6. High and low temperatures and general weather conditions, including presence of rain or snow.
   7. Testing and inspection.
   8. Accidents.
   9. Meetings and significant decisions.
   10. Unusual events.
   11. Stoppages, delays, shortages, and losses.
   12. Meter readings and similar recordings.
   13. Emergency procedures.
   14. Orders and requests of authorities having jurisdiction.

15. Change Orders received and implemented.
16. Construction Change Directives received and implemented.
17. Services connected and disconnected.
18. Equipment or system tests and startups.
19. Partial completions and occupancies.
20. Final Completions authorized.

B. Material Location Reports: At monthly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site. Indicate the following categories for stored materials:
   1. Material stored prior to previous report and remaining in storage.
   2. Material stored prior to previous report and since removed from storage and installed.
   3. Material stored following previous report and remaining in storage.

C. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

D. Unusual Event Reports: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, responses by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.
   1. Submit unusual event reports directly to Owner within one day(s) of an occurrence. Distribute copies of report to parties affected by the occurrence.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 013200

SECTION 013233 - PHOTOGRAPHIC DOCUMENTATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for the following:
   1. Preconstruction photographs.
   2. Periodic construction photographs.
   3. Final completion construction photographs.

B. Related Requirements:
   1. Section 017700 "Closeout Procedures" for submitting photographic documentation as Project Record Documents at Project closeout.

1.3 INFORMATIONAL SUBMITTALS

A. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.

B. Digital Photographs: Submit image files within three days of taking photographs.
   1. Submit photos by uploading to web-based project software site. Include copy of key plan indicating each photograph's location and direction.
   2. Identification: Provide the following information with each image description in web-based project software site:
      a. Name of Project.
      b. Name and contact information for photographer.
      c. Name of Architect.
      d. Name of Contractor.
      e. Date photograph was taken.
      f. Description of location, vantage point, and direction.
      g. Unique sequential identifier keyed to accompanying key plan.

1.4 FORMATS AND MEDIA

A. Digital Photographs: Provide color images in JPG format, produced by a digital camera with minimum sensor size of 12 megapixels, and at an image resolution of not less than 3200 by 2400 pixels, and with vibration-reduction technology. Use flash in low light levels or backlit

conditions.

B. Digital Images: Submit digital media as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.

C. Metadata: Record accurate date and time and GPS location data from camera.

D. File Names: Name media files with date Project area and sequential numbering suffix.

1.5 CONSTRUCTION PHOTOGRAPHS

A. General: Take photographs with maximum depth of field and in focus.
   1. Maintain key plan with each set of construction photographs that identifies each photographic location.

B. Preconstruction Photographs: Before commencement of excavation, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Architect.
   1. Flag construction limits before taking construction photographs.
   2. Take 20 photographs to show existing conditions adjacent to property before starting the Work.
   3. Take 20 photographs of existing buildings either on or adjoining property to accurately record physical conditions at start of construction.
   4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.

C. Periodic Construction Photographs: Take 50 photographs weekly. Select vantage points to show status of construction and progress since last photographs were taken.

D. Time-Lapse Sequence Construction Photographs: Take 20 photographs as indicated, to show status of construction and progress since last photographs were taken.
   1. Frequency: Take photographs Weekly.
   2. Vantage Points: Following suggestions by Architect and Contractor, photographer to select vantage points. During each of the following construction phases, take not less than two of the required shots from same vantage point each time to create a time-lapse sequence as follows:
      a. Commencement of the Work, through completion of subgrade construction.
      b. Above-grade structural framing.
      c. Exterior building enclosure.
      d. Interior Work, through date of Final Completion.

E. Final Completion Construction Photographs: Take 100 photographs after date of Final Completion for submission as Project Record Documents. Architect will inform photographer of desired vantage points.

F. Additional Photographs: Architect may request photographs in addition to periodic photographs specified. Additional photographs will be paid for by Change Order and are not included in the Contract Sum.
   1. Three days' notice will be given, where feasible.

2. In emergency situations, take additional photographs within 24 hours of request.
3. Circumstances that could require additional photographs include, but are not limited to, the following:
    a. Special events planned at Project site.
    b. Immediate follow-up when on-site events result in construction damage or losses.
    c. Photographs to be taken at fabrication locations away from Project site. These photographs are not subject to unit prices or unit-cost allowances.
    d. Final Completion of a major phase or component of the Work.
    e. Extra record photographs at time of final acceptance.
    f. Owner's request for special publicity photographs.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 013233

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Submittal schedule requirements.
   2. Administrative and procedural requirements for submittals.

B. Related Requirements:
   1. Section 013100 "Project Management and Coordination" for submitting coordination drawings and subcontract list and for requirements for web-based Project software.
   2. Section 013200 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
   3. Section 013233 "Photographic Documentation" for submitting preconstruction photographs, periodic construction photographs, and final completion construction photographs.
   4. Section 014000 "Quality Requirements" for submitting test and inspection reports, and schedule of tests and inspections.
   5. Section 017700 "Closeout Procedures" for submitting closeout submittals and maintenance material submittals.
   6. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
   7. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.

1.3 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Architect's and Contractor's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's and Contractor’s responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

1.4 SUBMITTAL SCHEDULE

A. Submittal Schedule: Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and Contractor and additional time for handling and reviewing submittals required by those corrections.
   1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
   2. Initial Submittal: Submit concurrently with startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
   3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.
      a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.
   4. Format: Arrange the following information in a tabular format:
      a. Scheduled date for first submittal.
      b. Specification Section number and title.
      c. Submittal Category: Action; informational.
      d. Name of subcontractor.
      e. Description of the Work covered.
      f. Scheduled date for Architect's and Contractor’s final release or approval.
      g. Scheduled dates for purchasing.
      h. Scheduled date of fabrication.
      i. Scheduled dates for installation.
      j. Activity or event number.

1.5 SUBMITTAL FORMATS

A. Use Designer’s Submittal Cover Form located after this section for all submittals.

B. Submittal Information: Include the following information in each submittal:
   1. Project name.
   2. Date.
   3. Name of Architect.
   4. Name of Contractor.
   5. Name of firm or entity that prepared submittal.
   6. Names of subcontractor, manufacturer, and supplier.
   7. Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier; and alphanumeric suffix for resubmittals.
   8. Category and type of submittal.
   9. Submittal purpose and description.
   10. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
   11. Drawing number and detail references, as appropriate.
   12. Indication of full or partial submittal.

13. Location(s) where product is to be installed, as appropriate.
14. Other necessary identification.
15. Remarks.
16. Signature of transmitter.

C. Options: Identify options requiring selection by Architect.

D. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Architect and Contractor on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.

E. Submittals for Web-Based Project Software: Prepare submittals as PDF files, or other format indicated by Project software website.

1.6 SUBMITTAL PROCEDURES

A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
   1. Web-Based Project Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
   1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
   2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
   3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
   4. Coordinate transmittal of submittals for related parts of the Work specified in different Sections so processing will not be delayed because of need to review submittals concurrently for coordination.
      a. Architect reserve the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
   1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
   2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
   3. Resubmittal Review: Allow 15 days for review of each resubmittal.

4. Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow 21 days for initial review of each submittal.
5. Concurrent Consultant Review: Where the Contract Documents indicate that submittals may be transmitted simultaneously to Architect and to Architect's consultants, allow 15 days for review of each submittal. Submittal will be returned to Contractor, through Architect.
    a. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Architect.

D. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
1. Note date and content of previous submittal.
2. Note date and content of revision in label or title block and clearly indicate extent of revision.
3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.

E. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

F. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

1.7 SUBMITTAL REQUIREMENTS

A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
2. Mark each copy of each submittal to show which products and options are applicable.
3. Include the following information, as applicable:
    a. Manufacturer's catalog cuts.
    b. Manufacturer's product specifications.
    c. Standard color charts.
    d. Statement of compliance with specified referenced standards.
    e. Testing by recognized testing agency.
    f. Application of testing agency labels and seals.
    g. Notation of coordination requirements.
    h. Availability and delivery time information.
4. For equipment, include the following in addition to the above, as applicable:
    a. Wiring diagrams that show factory-installed wiring.
    b. Printed performance curves.
    c. Operational range diagrams.
    d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
5. Submit Product Data before Shop Drawings, and before or concurrent with Samples.

B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data unless submittal based on Architect's digital data drawing files is otherwise permitted.
   1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
      a. Identification of products.
      b. Schedules.
      c. Compliance with specified standards.
      d. Notation of coordination requirements.
      e. Notation of dimensions established by field measurement.
      f. Relationship and attachment to adjoining construction clearly indicated.
      g. Seal and signature of professional engineer if specified.

C. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other materials.
   1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
   2. Identification: Permanently attach label on unexposed side of Samples that includes the following:
      a. Project name and submittal number.
      b. Generic description of Sample.
      c. Product name and name of manufacturer.
      d. Sample source.
      e. Number and title of applicable Specification Section.
      f. Specification paragraph number and generic name of each item.
   3. Web-Based Project Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.
   4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
      a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
      b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
   5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
      a. Number of Samples: Submit three full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.
   6. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

a. Number of Samples: Submit three sets of Samples. Architect will retain two Sample sets; remainder will be returned. Mark up and retain one returned Sample set as a project record Sample.
   1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
   2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.

D. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
   1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
   2. Manufacturer and product name, and model number if applicable.
   3. Number and name of room or space.
   4. Location within room or space.

E. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.

F. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.

G. Certificates:
   1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
   2. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
   3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
   4. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
   5. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
   6. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.

H. Test and Research Reports:
   1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
   2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
   3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
   4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
   5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
   6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
      a. Name of evaluation organization.
      b. Date of evaluation.
      c. Time period when report is in effect.
      d. Product and manufacturers' names.
      e. Description of product.
      f. Test procedures and results.
      g. Limitations of use.

1.8 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
   1. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to Architect.

B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF file paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
   1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

1.9 CONTRACTOR'S REVIEW

A. Action Submittals and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.

B. Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp indication in web-based Project software. Include name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
   1. Architect will not review submittals received from Contractor that do not have Contractor's review and approval.

1.10 ARCHITECT'S REVIEW

A. Action Submittals: Architect will review each submittal, indicate corrections or revisions required, and return it.
   1. Submittals by Web-Based Project Software: Architect will indicate, on Project software website, the appropriate action.

B. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.

C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.

D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

E. Architect will discard submittals received from sources other than Contractor.

F. Submittals not required by the Contract Documents will be returned by Architect without action.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 013300

SUBMITTAL COVER FORM

PROJECT: NC Museum of Art East Building and Museum Park Improvements

PROJECT NO.: 22-028

TO: HH Architecture
1100 Dresser Court
Raleigh, NC 27609

FROM: _____

_____

_____

_____CONTRACTOR _____SUBCONTRACTOR

We submit for your consideration the following product for the above project:

SPECIFICATION SECTION	SPECIFICATION PARAGRAPH	DESCRIPTION

TYPE OF SUBMITTAL:

_____ Specified Brand Product
_____ Proposed Equivalent Product to Specified Brand
_____ Product Meeting Performance Specification (No Brand Specified)

We warrant the following:

a. We have personally investigated the proposed product, and determined that it is equal in all respects to that specified and/or performance specification requirements;
b. We will provide the specified guarantee for this product;
c. We will coordinate installation of this product into the work, making such changes as maybe required for the work to be complete in all respects;
d. We have clearly indicated by marking as “Non-Complying Feature” each and every requirement of the Specifications that this product does not meet;
e. And, we waive all claims for additional costs related to this product which subsequently become apparent.

Attached hereto are complete technical data, including applicable laboratory reports, to demonstrate compliance with project requirements.

SUBMITTED BY:

_____ _____
SIGNATURE DATE

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
   1. Specific quality-assurance and quality-control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.
   2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
   3. Requirements for Contractor to provide quality-assurance and quality-control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions of this Section.
   4. Specific test and inspection requirements are not specified in this Section.

1.3 DEFINITIONS

A. Experienced: When used with an entity or individual, "experienced" unless otherwise further described means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

B. Field Quality-Control Tests: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.
   1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).

D. Mockups: Full-size physical assemblies that are constructed on-site either as freestanding temporary built elements or as part of permanent construction. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
   1. Integrated Exterior Mockups: Mockups of the exterior envelope constructed on-site as freestanding temporary built elements or as part of permanent construction, consisting of multiple products, assemblies, and subassemblies.

E. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.

F. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) according to 29 CFR 1910.7, by a testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

G. Source Quality-Control Tests: Tests and inspections that are performed at the source; for example, plant, mill, factory, or shop.

H. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

I. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Architect.

1.4 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
   1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.

1.5 CONFLICTING REQUIREMENTS

A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements are specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Architect for direction before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.6 ACTION SUBMITTALS

A. Delegated-Design Services Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.7 INFORMATIONAL SUBMITTALS

A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.

B. Qualification Data: For Contractor's quality-control personnel.

C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems:
   1. Seismic-force-resisting system, designated seismic system, or component listed in the Statement of Special Inspections.
   2. Main wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.

D. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
   1. Specification Section number and title.
   2. Entity responsible for performing tests and inspections.
   3. Description of test and inspection.
   4. Identification of applicable standards.
   5. Identification of test and inspection methods.
   6. Number of tests and inspections required.
   7. Time schedule or time span for tests and inspections.
   8. Requirements for obtaining samples.

9. Unique characteristics of each quality-control service.

E. Reports: Prepare and submit certified written reports and documents as specified.

F. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

1.8 CONTRACTOR'S QUALITY-CONTROL PLAN

A. Quality-Control Plan, General: Submit quality-control plan within 10 days of Notice to Proceed, and not less than five days prior to preconstruction conference. Submit in format acceptable to Architect. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's Construction Schedule.

B. Quality-Control Personnel Qualifications: Engage qualified personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.
   1. Project quality-control manager may also serve as Project superintendent.

C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.

D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:
   1. Contractor-performed tests and inspections including Subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections. Distinguish source quality-control tests and inspections from field quality-control tests and inspections.
   2. Special inspections required by authorities having jurisdiction and indicated on the Statement of Special Inspections.

E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mockups.

F. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Architect has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.9 REPORTS AND DOCUMENTS

A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
   1. Date of issue.
   2. Project title and number.
   3. Name, address, telephone number, and email address of testing agency.
   4. Dates and locations of samples and tests or inspections.
   5. Names of individuals making tests and inspections.
   6. Description of the Work and test and inspection method.
   7. Identification of product and Specification Section.
   8. Complete test or inspection data.
   9. Test and inspection results and an interpretation of test results.
   10. Record of temperature and weather conditions at time of sample taking and testing and inspection.
   11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
   12. Name and signature of laboratory inspector.
   13. Recommendations on retesting and re-inspecting.

B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
   1. Name, address, telephone number, and email address of technical representative making report.
   2. Statement on condition of substrates and their acceptability for installation of product.
   3. Statement that products at Project site comply with requirements.
   4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
   5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
   6. Statement whether conditions, products, and installation will affect warranty.
   7. Other required items indicated in individual Specification Sections.

C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
   1. Name, address, telephone number, and email address of factory-authorized service representative making report.
   2. Statement that equipment complies with requirements.
   3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
   4. Statement whether conditions, products, and installation will affect warranty.
   5. Other required items indicated in individual Specification Sections.

1.10 QUALITY ASSURANCE

A. General: Qualifications paragraphs in this article establish the minimum qualification levels

required; individual Specification Sections specify additional requirements.

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.

C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.

F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
   1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.

G. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

H. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
   1. Contractor responsibilities include the following:
      a. Provide test specimens representative of proposed products and construction.
      b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
      c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
      d. Build site-assembled test assemblies and mockups using installers who will perform

same tasks for Project.

e. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.

f. When testing is complete, remove test specimens and test assemblies, mockups, and laboratory mockups; do not reuse products on Project.

J. Integrated Exterior Mockups: Construct integrated exterior mockup according to approved Shop Drawings. Coordinate installation of exterior envelope materials and products for which mockups are required in individual Specification Sections, along with supporting materials. Comply with requirements in "Mockups" Paragraph.

1.11 QUALITY CONTROL

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.

1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
2. Payment for these services will be made from testing and inspection allowances, as authorized by Change Orders.
3. Costs for retesting and re-inspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.

B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.

1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
2. Engage a qualified testing agency to perform quality-control services.
   a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspection will be performed.
4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
5. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Retesting/Re-inspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and re-inspecting, for construction that replaced Work that failed to comply with the Contract Documents.

D. Testing Agency Responsibilities: Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
   1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
   2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
   3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
   4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
   5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
   6. Do not perform duties of Contractor.

E. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."

F. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

G. Associated Contractor Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
   1. Access to the Work.
   2. Incidental labor and facilities necessary to facilitate tests and inspections.
   3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
   4. Facilities for storage and field curing of test samples.
   5. Delivery of samples to testing agencies.
   6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
   7. Security and protection for samples and for testing and inspection equipment at Project site.

H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.
   1. Schedule times for tests, inspections, obtaining samples, and similar activities.

I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents as a component of Contractor's quality-control plan. Coordinate and submit concurrently with Contractor's Construction Schedule. Update as the Work progresses.
   1. Distribution: Distribute schedule to Owner, Architect, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.12 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: Owner will engage a qualified special inspector to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner, as indicated in the Statement of Special Inspections attached to this Section, and as follows:
   1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
   2. Notifying Architect and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
   3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect and with copy to Contractor and to authorities having jurisdiction.
   4. Submitting a final report of special tests and inspections at Final Acceptance, which includes a list of unresolved deficiencies.
   5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
   6. Retesting and reinspection of corrected work.

B. Special Tests and Inspections: Conducted by a qualified special inspector as required by authorities having jurisdiction, as indicated in individual Specification Sections and in the Statement of Special Inspections attached to this Section, and as follows:
   1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
   2. Notifying Architect and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
   3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect with copy to Contractor and to authorities having jurisdiction.
   4. Submitting a final report of special tests and inspections at Final Acceptance, which includes a list of unresolved deficiencies.
   5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
   6. Retesting and re-inspecting corrected work.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 REPAIR AND PROTECTION

A. General: On completion of testing, inspection, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
   1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

SECTION 014100 – SPECIAL INSPECTION SERVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for Special Inspection services.

B. Certain structural components of the Project will be subject to the requirements for Special Inspections. Special Inspections will be applicable to the following specification sections:
1. Section 03 30 00 Cast-In-Place Concrete
2. Section 04 20 00 Unit Masonry
3. Section 05 12 00 Structural Steel Framing
4. Section 05 31 00 Steel Decking
5. Section 05 40 00 Cold-Formed Metal Framing
6. Section 03 01 30 Strengthening of Cast-In-Place Concrete
7. Section 31 00 00 Earth Moving

C. The Owner will procure and bear all costs of the Special Inspector and the Independent Testing Laboratory, except as otherwise noted. The Special Inspector will be the manager of the Special Inspection process. The Special Inspector checks the certification of all other inspecting agents required by Special Inspections and coordinates their activities. The Special Inspector carries the exclusive responsibility for assuring that the inspections indicated are performed. The Statement of Special Inspections will be required by the Building Official as a condition for building permit issuance.

D. Requirements for Special Inspections are outlined in the Statement and Schedule of Special Inspections included at the end of this section.
1. Specific quality-assurance and control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
3. Requirements for Contractor to provide quality-assurance and -control services required by Architect, Owner, Construction Manager, or authorities having jurisdiction are not limited by provisions of this Section.

E. Special Inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sectiosn may also cover production of standard products.
2. Specified tests, inspections, and related actions do not limit Contractor’s other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.

3. Requirements for Contractor to provide quality-assurance and -control services required by Architect, Owner, Construction Manager, or authorities having jurisdiction are not limited by provisions of this Section.
4. Specific test and inspection requirements are not specified in this Section.

F. Related Sections: The following Sections contain requirements that relate to this Section:
1. Section 01 40 00 “Quality Requirements" specifies requirements for inspection and test requirements.

1.3 RESPONSIBILITIES

A. Contractor Responsibilities: Contractor shall provide and include in the Contract Sum, inspections, tests, and other similar quality-control services specified elsewhere in the Contract Documents and required by authorities having jurisdiction except where they are specifically indicated to be the Owner’s responsibility, or are provided by another identified entity.
1. Retesting: The Contractor is responsible for retesting where results of inspections, tests, or other quality-control services prove unsatisfactory and indicate noncompliance with Contract Document requirements, regardless of whether the original test was Contractor's responsibility.
   a. The Contractor shall correct deficiencies in work that inspections and laboratory test reports have indicated to be not in compliance with requirements.
   b. The cost of retesting construction, revised or replaced by the Contractor, is the Contractor's responsibility where required tests performed on original construction indicated noncompliance with Contract Document requirements.
2. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
   a. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
3. Associated Services: The Contractor shall cooperate with agencies performing required inspections, tests, and similar services, and provide reasonable auxiliary services as requested. Notify the agency sufficiently in advance of operations to permit assignment of personnel. Auxiliary services required include, but are not limited to, the following:
   a. Provide access to the Work.
   b. Furnish incidental labor and facilities necessary to facilitate inspections and tests.
   c. Take adequate quantities of representative samples of materials that require testing or assist the agency in taking samples.
   d. Provide and maintain for the sole use of the Special Inspector or Special Inspectors adequate facilities for safe storage and proper curing of test samples on the Project Site.
   e. Provide the agency with a preliminary design mix proposed for use for materials mixes that require control by the testing agency.
   f. Provide security and protection of samples and test equipment at the Project Site.
   g. The Contractor shall designate a representative (the superintendent or an assistant to the superintendent) who shall be the direct point-of-contact with the Special Inspector during each phase of the work. Discrepancies noted during the progress of the work will be reported to the Contractor’s representative for corrective action. Communications given by the Special Inspector to the Contractor’s representative shall be as binding as if given to the Contractor.

B. Special Inspector Responsibilities:

1. The Special Inspector shall conduct and interpret tests, state in each report whether test specimens comply with requirements, specifically state any deviations therefrom, and record work required and performed to correct deficiencies.
2. The Special Inspector will keep records of all inspection and tests which will be furnished to the Building Official, the Architect, and the Structural Engineer of Record.
3. The Special Inspector shall notify the Architect, Construction Manager, and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services. All discrepancies will be brought to the immediate attention of the Contractor for correction. If discrepancies are not corrected, the discrepancies will be brought to the attention of the Building Official and the Structural Engineer of Record.
4. A final report documenting completion of all required special inspections and corrections of any discrepancies noted will be submitted to the Building Official by the Special Inspector prior to, and as a condition of, issuance of the Certificate of Use and Occupancy.
5. The Special Inspector shall not perform any duties of the Contractor.
6. The Special Inspector shall not release, revoke, alter, decrease, or increase the Contract Document requirements.

C. Independent Testing Laboratory Responsibilities: The Independent Testing Laboratory engaged to perform inspections, sampling, and testing of materials and construction specified in individual Sections shall cooperate with the Architect and the Contractor in performance of the Laboratory's duties. The Laboratory shall provide qualified personnel to perform required inspections and tests.
1. Notify Architect, Construction Manager, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Shall not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.

D. Coordination: The Contractor and each agency engaged to perform inspection, tests and similar services shall coordinate the sequence of activities to accommodate required services with a minimum of delay. In addition, the Contractor and each agency shall coordinate activities to avoid the necessity of removing and replacing construction to accommodate inspections and tests.
1. The Contractor is responsible for scheduling times for inspections, tests, taking samples, and similar activities.

1.4 SUBMITTALS

A. The Special Inspector and the Independent Testing Laboratory shall submit a certified written report, in duplicate, of each inspection, test, or similar service to the Architect.
1. Submit additional copies of each written report directly to the governing authority, when the authority so directs.
2. Report Data: Written reports of each inspection, test, or similar service include, but are not limited to, the following:
    a. Date of issue.
    b. Project title and number.
    c. Name, address, and telephone number of testing agency.
    d. Dates and locations of samples and tests or inspections.
    e. Names of individuals making the inspection or test.

f. Designation of the Work and test method.
g. Identification of product and Specification Section.
h. Complete inspection or test data.
i. Test results and an interpretation of test results.
j. Ambient conditions at the time of sample taking and testing.
k. Comments or professional opinion on whether inspected or tested Work complies with Contract Document requirements.
l. Name and signature of laboratory inspector.
m. Recommendations on retesting.

1.5 QUALITY ASSURANCE

A. Qualification for Special Inspector: The Special Inspector shall be a Registered Professional Engineer, licensed in the State of North Carolina, experienced in performing special inspections and shall be approved by the Building Official and the Architect. The credentials of all Inspectors and testing technicians shall be provided if requested.

B. Qualifications for Independent Testing Laboratory: Engage independent inspection and testing laboratories, that are prequalified as complying with the American Council of Independent Laboratories' "Recommended Requirements for Independent Laboratory Qualification" and that specialize in the types of inspections and tests to be performed.

1. Each independent inspection and testing agency engaged on the Project shall be authorized by authorities having jurisdiction to operate in the state where the Project is located.
2. Each independent inspection and testing agency engaged on the Project shall demonstrate that it has the experience and capability to conduct the required field and laboratory testing without delaying the progress of the work. The minimum requirements shall be as follows:
   a. Reinforced Concrete Testing –
      (1) ACI-CFTT Concrete Field Testing Technician – Grade 1
      (2) ACI-LTT Laboratory Testing Technician – Grade 1 or 2 and Strength Testing Technician
      (3) NICET-CT Concrete Technician – Level III
   b. Reinforced Concrete Inspection
      (1) ACI-CCI Concrete Construction Inspector
      (2) ICC-RCSI Reinforced Concrete Special Inspector
   c. Structural Steel
      (1) AWS-CWI Certified Welding Inspector
      (2) AWS/AISC-CSI Certified Steel Inspector
      (3) ICC-SWSI Structural Steel and Welding Inspector
   d. Non-Destructive Testing – American Society of Non-Destructive.
   e. Structural Masonry
      (1) ICC-SMSI Structural Masonry Special Inspector
   f. Spray-Applied Fireproofing
(1) ICC-SFSI Spray-Applied Fireproofing Special Inspector
   g. Prestressed Concrete
      (1) ICC-PCSI Prestressed Concrete Special Inspector
   h. Soils Testing
      (1) NICET-ST Soils Technician Level III
      (2) NICET-GET Geotechnical Engineering Technician Level III
   i. Exterior Insulation and Finish Systems (EIFS)
      (1) EDI EIFS Third Party Inspector

B. Pre-Construction Conference – Prior to the start of project construction, the Special Inspector shall conduct a Pre-Construction Conference to discuss the requirements for Special Inspections as well as the Administrative Procedures to be followed during the course of the project. Protocols for notification, documentation, and individual responsibilities shall be reviewed. Attendees shall include, but are not limited to:
   1. Owner
   2. Owner's Project Manager
   3. Owner's Project Inspector
   4. Owner's Independent Testing Agency
   5. Architect
   6. Structural Engineer
   7. Contractor's Project Manager

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
   1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 01 41 00

SECTION 014200 - REFERENCES

PART 1 GENERAL

1.1 SUMMARY

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.3 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.

B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.

C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."

D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."

E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.

F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.

H. "Provide": Furnish and install, complete and ready for the intended use.

I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.4 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
   1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.5 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."

B. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.
   1. AABC - Associated Air Balance Council; www.aabc.com.
   2. AAMA - American Architectural Manufacturers Association; www.aamanet.org.
   3. AAPFCO - Association of American Plant Food Control Officials; www.aapfco.org.
   4. AASHTO - American Association of State Highway and Transportation Officials; www.transportation.org.
   5. AATCC - American Association of Textile Chemists and Colorists; www.aatcc.org.
   6. ABMA - American Bearing Manufacturers Association; www.americanbearings.org.
   7. ABMA - American Boiler Manufacturers Association; www.abma.com.
   8. ACI - American Concrete Institute; (Formerly: ACI International); www.concrete.org.
   9. ACPA - American Concrete Pipe Association; www.concrete-pipe.org.
   10. AEIC - Association of Edison Illuminating Companies, Inc. (The); www.aeic.org.
   11. AF&PA - American Forest & Paper Association; www.afandpa.org.
   12. AGA - American Gas Association; www.aga.org.
   13. AHAM - Association of Home Appliance Manufacturers; www.aham.org.
   14. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
   15. AI - Asphalt Institute; www.asphaltinstitute.org.
   16. AIA - American Institute of Architects (The); www.aia.org.
   17. AISC - American Institute of Steel Construction; www.aisc.org.
   18. AISI - American Iron and Steel Institute; www.steel.org.
   19. AITC - American Institute of Timber Construction; www.aitc-glulam.org.
   20. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.

21. ANSI - American National Standards Institute; www.ansi.org.
22. AOSA - Association of Official Seed Analysts, Inc.; www.aosaseed.com.
23. APA - APA - The Engineered Wood Association; www.apawood.org.
24. APA - Architectural Precast Association; www.archprecast.org.
25. API - American Petroleum Institute; www.api.org.
26. ARI - Air-Conditioning & Refrigeration Institute; (See AHRI).
27. ARI - American Refrigeration Institute; (See AHRI).
28. ARMA - Asphalt Roofing Manufacturers Association; www.asphaltroofing.org.
29. ASCE - American Society of Civil Engineers; www.asce.org.
30. ASCE/SEI - American Society of Civil Engineers/Structural Engineering Institute; (See ASCE).
31. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.
32. ASME - ASME International; (American Society of Mechanical Engineers); www.asme.org.
33. ASSE - American Society of Safety Engineers (The); www.asse.org.
34. ASSE - American Society of Sanitary Engineering; www.asse-plumbing.org.
35. ASTM - ASTM International; www.astm.org.
36. ATIS - Alliance for Telecommunications Industry Solutions; www.atis.org.
37. AWEA - American Wind Energy Association; www.awea.org.
38. AWI - Architectural Woodwork Institute; www.awinet.org.
39. AWMAC - Architectural Woodwork Manufacturers Association of Canada; www.awmac.com.
40. AWPA - American Wood Protection Association; www.awpa.com.
41. AWS - American Welding Society; www.aws.org.
42. AWWA - American Water Works Association; www.awwa.org.
43. BHMA - Builders Hardware Manufacturers Association; www.buildershardware.com.
44. BIA - Brick Industry Association (The); www.gobrick.com.
45. BICSI - BICSI, Inc.; www.bicsi.org.
46. BIFMA - BIFMA International; (Business and Institutional Furniture Manufacturer's Association); www.bifma.org.
47. BISSC - Baking Industry Sanitation Standards Committee; www.bissc.org.
48. BWF - Badminton World Federation; (Formerly: International Badminton Federation); www.bissc.org.
49. CDA - Copper Development Association; www.copper.org.
50. CE - Conformite Europeenne; http://ec.europa.eu/growth/single-market/ce-marking/
51. CEA - Canadian Electricity Association; www.electricity.ca.
52. CEA - Consumer Electronics Association; www.ce.org.
53. CFFA - Chemical Fabrics and Film Association, Inc.; www.chemicalfabricsandfilm.com.
54. CFSEI - Cold-Formed Steel Engineers Institute; www.cfsei.org.
55. CGA - Compressed Gas Association; www.cganet.com.
56. CIMA - Cellulose Insulation Manufacturers Association; www.cellulose.org.
57. CISCA - Ceilings & Interior Systems Construction Association; www.cisca.org.
58. CISPI - Cast Iron Soil Pipe Institute; www.cispi.org.
59. CLFMI - Chain Link Fence Manufacturers Institute; www.chainlinkinfo.org.
60. CPA - Composite Panel Association; www.pbmdf.com.
61. CRI - Carpet and Rug Institute (The); www.carpet-rug.org.
62. CRRC - Cool Roof Rating Council; www.coolroofs.org.
63. CRSI - Concrete Reinforcing Steel Institute; www.crsi.org.

64. CSA - CSA Group; www.csa.ca.
65. CSA - CSA International; (Formerly: IAS - International Approval Services); www.csa-international.org.
66. CSI - Construction Specifications Institute (The); www.csinet.org.
67. CSSB - Cedar Shake & Shingle Bureau; www.cedarbureau.org.
68. CTI - Cooling Technology Institute; (Formerly: Cooling Tower Institute); www.cti.org.
69. CWC - Composite Wood Council; (See CPA).
70. DASMA - Door and Access Systems Manufacturers Association; www.dasma.com.
71. DHI - Door and Hardware Institute; www.dhi.org.
72. ECA - Electronic Components Association; (See ECIA).
73. ECAMA - Electronic Components Assemblies & Materials Association; (See ECIA).
74. ECIA - Electronic Components Industry Association; www.eciaonline.org.
75. EIA - Electronic Industries Alliance; (See TIA).
76. EIMA - EIFS Industry Members Association; www.eima.com.
77. EJMA - Expansion Joint Manufacturers Association, Inc.; www.ejma.org.
78. ESD - ESD Association; (Electrostatic Discharge Association); www.esda.org.
79. ESTA - Entertainment Services and Technology Association; (See PLASA).
80. ETL - Intertek (See Intertek); www.intertek.com.
81. EVO - Efficiency Valuation Organization; www.evo-world.org.
82. FCI - Fluid Controls Institute; www.fluidcontrolsinstitute.org.
83. FIBA - Federation Internationale de Basketball; (The International Basketball Federation); www.fiba.com.
84. FIVB - Federation Internationale de Volleyball; (The International Volleyball Federation); www.fivb.org.
85. FM Approvals - FM Approvals LLC; www.fmglobal.com.
86. FM Global - FM Global; (Formerly: FMG - FM Global); www.fmglobal.com.
87. FRSA - Florida Roofing, Sheet Metal & Air Conditioning Contractors Association, Inc.; www.floridaroof.com.
88. FSA - Fluid Sealing Association; www.fluidsealing.com.
89. FSC - Forest Stewardship Council U.S.; www.fscus.org.
90. GA - Gypsum Association; www.gypsum.org.
91. GANA - Glass Association of North America; www.glasswebsite.com.
92. GS - Green Seal; www.greenseal.org.
93. HI - Hydraulic Institute; www.pumps.org.
94. HI/GAMA - Hydronics Institute/Gas Appliance Manufacturers Association; (See AHRI).
95. HMMA - Hollow Metal Manufacturers Association; (See NAAMM).
96. HPVA - Hardwood Plywood & Veneer Association; www.hpva.org.
97. HPW - H. P. White Laboratory, Inc.; www.hpwhite.com.
98. IAPSC - International Association of Professional Security Consultants; www.iapsc.org.
99. IAS - International Accreditation Service; www.iasonline.org.
100. IAS - International Approval Services; (See CSA).
101. ICBO - International Conference of Building Officials; (See ICC).
102. ICC - International Code Council; www.iccsafe.org.
103. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
104. ICPA - International Cast Polymer Alliance; www.icpa-hq.org.
105. ICRI - International Concrete Repair Institute, Inc.; www.icri.org.
106. IEC - International Electrotechnical Commission; www.iec.ch.
107. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
108. IES - Illuminating Engineering Society; (Formerly: Illuminating Engineering Society of

North America); www.ies.org.
109. IESNA - Illuminating Engineering Society of North America; (See IES).
110. IEST - Institute of Environmental Sciences and Technology; www.iest.org.
111. IGMA - Insulating Glass Manufacturers Alliance; www.igmaonline.org.
112. IGSHPA - International Ground Source Heat Pump Association; www.igshpa.okstate.edu.
113. ILI - Indiana Limestone Institute of America, Inc.; www.iliai.com.
114. Intertek - Intertek Group; (Formerly: ETL SEMCO; Intertek Testing Service NA); www.intertek.com.
115. ISA - International Society of Automation (The); (Formerly: Instrumentation, Systems, and Automation Society); www.isa.org.
116. ISAS - Instrumentation, Systems, and Automation Society (The); (See ISA).
117. ISFA - International Surface Fabricators Association; (Formerly: International Solid Surface Fabricators Association); www.isfanow.org.
118. ISO - International Organization for Standardization; www.iso.org.
119. ISSFA - International Solid Surface Fabricators Association; (See ISFA).
120. ITU - International Telecommunication Union; www.itu.int/home.
121. KCMA - Kitchen Cabinet Manufacturers Association; www.kcma.org.
122. LMA - Laminating Materials Association; (See CPA).
123. LPI - Lightning Protection Institute; www.lightning.org.
124. MBMA - Metal Building Manufacturers Association; www.mbma.com.
125. MCA - Metal Construction Association; www.metalconstruction.org.
126. MFMA - Maple Flooring Manufacturers Association, Inc.; www.maplefloor.org.
127. MFMA - Metal Framing Manufacturers Association, Inc.; www.metalframingmfg.org.
128. MHIA - Material Handling Industry of America; www.mhia.org.
129. MIA - Marble Institute of America; www.marble-institute.com.
130. MMPA - Moulding & Millwork Producers Association; www.wmmpa.com.
131. MPI - Master Painters Institute; www.paintinfo.com.
132. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry Inc.; www.mss-hq.org.
133. NAAMM - National Association of Architectural Metal Manufacturers; www.naamm.org.
134. NACE - NACE International; (National Association of Corrosion Engineers International); www.nace.org.
135. NADCA - National Air Duct Cleaners Association; www.nadca.com.
136. NAIMA - North American Insulation Manufacturers Association; www.naima.org.
137. NBGQA - National Building Granite Quarries Association, Inc.; www.nbgqa.com.
138. NBI - New Buildings Institute; www.newbuildings.org.
139. NCAA - National Collegiate Athletic Association (The); www.ncaa.org.
140. NCMA - National Concrete Masonry Association; www.ncma.org.
141. NEBB - National Environmental Balancing Bureau; www.nebb.org.
142. NECA - National Electrical Contractors Association; www.necanet.org.
143. NeLMA - Northeastern Lumber Manufacturers Association; www.nelma.org.
144. NEMA - National Electrical Manufacturers Association; www.nema.org.
145. NETA - InterNational Electrical Testing Association; www.netaworld.org.
146. NFHS - National Federation of State High School Associations; www.nfhs.org.
147. NFPA - National Fire Protection Association; www.nfpa.org.
148. NFPA - NFPA International; (See NFPA).
149. NFRC - National Fenestration Rating Council; www.nfrc.org.
150. NHLA - National Hardwood Lumber Association; www.nhla.com.
151. NLGA - National Lumber Grades Authority; www.nlga.org.

152. NOFMA - National Oak Flooring Manufacturers Association; (See NWFA).
153. NOMMA - National Ornamental & Miscellaneous Metals Association; www.nomma.org.
154. NRCA - National Roofing Contractors Association; www.nrca.net.
155. NRMCA - National Ready Mixed Concrete Association; www.nrmca.org.
156. NSF - NSF International; www.nsf.org.
157. NSPE - National Society of Professional Engineers; www.nspe.org.
158. NSSGA - National Stone, Sand & Gravel Association; www.nssga.org.
159. NTMA - National Terrazzo & Mosaic Association, Inc. (The); www.ntma.com.
160. NWFA - National Wood Flooring Association; www.nwfa.org.
161. PCI - Precast/Prestressed Concrete Institute; www.pci.org.
162. PDI - Plumbing & Drainage Institute; www.pdionline.org.
163. PLASA - PLASA; (Formerly: ESTA - Entertainment Services and Technology Association); http://www.plasa.org.
164. RCSC - Research Council on Structural Connections; www.boltcouncil.org.
165. RFCI - Resilient Floor Covering Institute; www.rfci.com.
166. RIS - Redwood Inspection Service; www.redwoodinspection.com.
167. SAE - SAE International; www.sae.org.
168. SCTE - Society of Cable Telecommunications Engineers; www.scte.org.
169. SDI - Steel Deck Institute; www.sdi.org.
170. SDI - Steel Door Institute; www.steeldoor.org.
171. SEFA - Scientific Equipment and Furniture Association (The); www.sefalabs.com.
172. SEI/ASCE - Structural Engineering Institute/American Society of Civil Engineers; (See ASCE).
173. SIA - Security Industry Association; www.siaonline.org.
174. SJI - Steel Joist Institute; www.steeljoist.org.
175. SMA - Screen Manufacturers Association; www.smainfo.org.
176. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
177. SMPTE - Society of Motion Picture and Television Engineers; www.smpte.org.
178. SPFA - Spray Polyurethane Foam Alliance; www.sprayfoam.org.
179. SPIB - Southern Pine Inspection Bureau; www.spib.org.
180. SPRI - Single Ply Roofing Industry; www.spri.org.
181. SRCC - Solar Rating & Certification Corporation; www.solar-rating.org.
182. SSINA - Specialty Steel Industry of North America; www.ssina.com.
183. SSPC - SSPC: The Society for Protective Coatings; www.sspc.org.
184. STI - Steel Tank Institute; www.steeltank.com.
185. SWI - Steel Window Institute; www.steelwindows.com.
186. SWPA - Submersible Wastewater Pump Association; www.swpa.org.
187. TCA - Tilt-Up Concrete Association; www.tilt-up.org.
188. TCNA - Tile Council of North America, Inc.; www.tileusa.com.
189. TEMA - Tubular Exchanger Manufacturers Association, Inc.; www.tema.org.
190. TIA - Telecommunications Industry Association (The); (Formerly: TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance); www.tiaonline.org.
191. TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance; (See TIA).
192. TMS - The Masonry Society; www.masonrysociety.org.
193. TPI - Truss Plate Institute; www.tpinst.org.
194. TPI - Turfgrass Producers International; www.turfgrasssod.org.

195. TRI - Tile Roofing Institute; www.tileroofing.org.
196. UL - Underwriters Laboratories Inc.; http://www.ul.com.
197. UNI - Uni-Bell PVC Pipe Association; www.uni-bell.org.
198. USAV - USA Volleyball; www.usavolleyball.org.
199. USGBC - U.S. Green Building Council; www.usgbc.org.
200. USITT - United States Institute for Theatre Technology, Inc.; www.usitt.org.
201. WA - Wallcoverings Association; www.wallcoverings.org.
202. WASTEC - Waste Equipment Technology Association; www.wastec.org.
203. WCLIB - West Coast Lumber Inspection Bureau; www.wclib.org.
204. WCMA - Window Covering Manufacturers Association; www.wcmanet.org.
205. WDMA - Window & Door Manufacturers Association; www.wdma.com.
206. WI - Woodwork Institute; www.wicnet.org.
207. WSRCA - Western States Roofing Contractors Association; www.wsrca.com.
208. WWPA - Western Wood Products Association; www.wwpa.org.

C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is believed to be accurate as of the date of the Contract Documents.
   1. DIN - Deutsches Institut fur Normung e.V.; www.din.de.
   2. IAPMO - International Association of Plumbing and Mechanical Officials; www.iapmo.org.
   3. ICC - International Code Council; www.iccsafe.org.
   4. ICC-ES - ICC Evaluation Service, LLC; www.icc-es.org.
   5. www.txforestservice.tamu.edu.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 014200

SECTION 014339 - MOCKUPS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Integrated exterior mockups.
   2. Integrated interior mockups.

B. Related Requirements:
   1. Section 014000 "Quality Requirements" for quality assurance requirements for aesthetic and workmanship mockups specified in other Sections.

1.2 DEFINITIONS

A. Integrated Exterior Mockups: Mockups of the exterior envelope constructed on-site as freestanding temporary built elements, consisting of multiple products, assemblies, and subassemblies.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Meet with Owner, Design-Builder, Architect, testing and inspecting agency representative, and installers of major systems whose Work is included in mockups.
   2. Review coordination of equipment and furnishings provided by the Owner for room mockups.
   3. Review locations and extent of mockups.
   4. Review testing procedures to be performed on mockups.
   5. Review and finalize schedule for mockups, and verify availability of materials, personnel, equipment, and facilities needed to complete mockups and testing and maintain schedule for the Work.

1.4 ACTION SUBMITTALS

A. Shop Drawings: For integrated exterior mockups.
   1. Include plans, elevations, sections, and mounting, attachment, and support details.
   2. Indicate manufacturer and model number of individual components, subassemblies, and assemblies.
   3. Include site location drawing indicating orientation of mockup.
   4. Revise and resubmit Shop Drawings to reflect approved modifications in details and component interfaces resulting from changes made during testing procedures.

B. Delegated Design Submittal: For temporary structural supports for mockups not attached to

building structure, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Preconstruction Test Reports: For integrated exterior mockups.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified in accordance with ASTM E699 for testing indicated and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025 and acceptable to Owner and Architect.

B. Build mockups to do the following:
   1. Verify selections made under Sample submittals.
   2. Demonstrate aesthetic effects.
   3. Demonstrate the qualities of products and workmanship.
   4. Demonstrate acceptable coordination between components and systems.
   5. Perform preconstruction testing, such as window air- and water-leakage testing.

C. Fabrication: Before fabricating or installing portions of the Work requiring mockups, build mockups for each form of construction and finish required. Use materials and installation methods as required for the Work.
   1. Build mockups of size indicated.
   2. Build mockups in location indicated or, if not indicated, as directed by Architect or Design-Builder.
   3. Employ supervisory personnel who will oversee mockup construction. Employ workers who will be employed to perform same tasks during the construction at Project.
   4. Demonstrate the proposed range of aesthetic effects and workmanship.
   5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
   6. Demolish and remove mockups when directed unless otherwise indicated.

D. Notifications:
   1. Notify Architect and Design-Builder seven days in advance of the dates and times when mockups will be constructed.
   2. Notify Architect and Design-Builder 14 days in advance of the dates and times when mockups will be tested.
   3. Allow seven days for initial review and each re-review of each mockup.

E. Approval: Obtain Architect's and Design-Builder's approval of mockups before starting fabrication or construction of corresponding Work.
   1. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
   2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations

in writing.

1.7 COORDINATION

A. Coordinate schedule for construction of mockups, so construction, testing, and review of mockups do not impact Project schedule.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design support structure for free-standing mockups.

B. Structural Performance:
   1. Wind Loads: As indicated on Drawings.

2.2 EXTERIOR MOCKUPS

A. Construct mockups to demonstrate constructability, coordination of trades, and sequencing of Work; and to ensure materials, components, subassemblies, assemblies, and interfaces integrate into a system complying with indicated performance and aesthetic requirements.

B. Design and construct foundation and superstructure to support free-standing exterior mockups.

C. Build exterior mockups using installers and construction methods that will be used in completed construction.

D. Use specified products that have been approved by Architect. Coordinate installation of materials and products specified in individual Specification Sections that include Work included in integrated exterior mockups.

E. The Work of exterior mockups includes, but is not limited to, the following:
   1. Masonry veneer.
   2. Cold-formed metal framing and sheathing.
   3. Air and weather barriers.
   4. Thermal insulation.
   5. Through-wall flashing.
   6. Flashing and sheet metal trim.
   7. Joint sealants.
   8. Metal wall panels.
   9. Aluminum-framed entrances and storefront.
   10. Glazed curtain walls.
   11. Glazing.
   12. Parapet coping caps.

F. Photographic Documentation: Document construction of integrated exterior mockups with photographs. Provide photographs showing details of interface of different materials and assemblies.
   1. Document testing procedures, including water leakage and other deficiencies. Photograph modifications to component interfaces intended to correct deficiencies.

G. Provide and document modifications to construction details and interfaces between components and systems required to properly sequence the Work, or to pass performance testing requirements. Obtain Architect's approval for modifications.

2.3 INTEGRATED INTERIOR MOCKUPS

A. Construct mockups to demonstrate constructability, coordination of trades, and sequencing of Work; and to ensure materials, components, subassemblies, assemblies, and interfaces integrate into a system complying with indicated performance and aesthetic requirements.

B. Build interior mockups using installers and construction methods that will be used in completed construction.

C. Use specified products that have been approved by Architect. Coordinate installation of materials and products specified in individual Specification Sections that include Work included in integrated exterior mockups.

D. The Work of interior mockups includes, but is not limited to, the following:
   1. Interior wood wall panels.
   2. Track railing with metal mesh infill panels.
   3. Railing with vertical pickets.

E. Photographic Documentation: Document construction of integrated exterior mockups with photographs. Provide photographs showing details of interface of different materials and assemblies.
   1. Document testing procedures, including water leakage and other deficiencies. Photograph modifications to component interfaces intended to correct deficiencies.

F. Provide and document modifications to construction details and interfaces between components and systems required to properly sequence the Work, or to pass performance testing requirements. Obtain Architect's approval for modifications.

PART 3 EXECUTION - NOT USED

END OF SECTION 014339

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.1 SUMMARY

A. Work Results:

B. Principal Products:

C. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

D. Related Requirements:
1. Section 011000 "Summary" for work restrictions and limitations on utility interruptions.

1.2 USE CHARGES

A. See Supplementary General Conditions.

1.3 INFORMATIONAL SUBMITTALS

A. Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.

B. Implementation and Termination Schedule: Within 15 days of date established for commencement of the Work, submit schedule indicating implementation and termination dates of each temporary utility.

C. Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, typestyles, graphic elements, and message content.

D. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.

E. Moisture- and Mold-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage and mold. Describe delivery, handling, storage, installation, and protection provisions for materials subject to water absorption or water damage.
1. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and requirements for replacing water-damaged Work.

2. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.
3. Indicate methods to be used to avoid trapping water in finished work.

F. Dust- and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Include the following:
1. Locations of dust-control partitions at each phase of work.
2. HVAC system isolation schematic drawing.
3. Location of proposed air-filtration system discharge.
4. Waste-handling procedures.
5. Other dust-control measures.

G. Noise and Vibration Control Plan: Identify construction activities that may impact the occupancy and use of existing spaces within the building or adjacent existing buildings, whether occupied by others, or occupied by Owner. Include the following:
1. Methods used to meet the goals and requirements of Owner.
2. Concrete cutting method(s) to be used.
3. Location of construction devices on the site.
4. Show compliance with the use and maintenance of quieted construction devices for the duration of the Project.
5. Indicate activities that may disturb building occupants and that are planned to be performed during non-standard working hours as coordinated with Owner.
6. Indicate locations of sensitive areas or other areas requiring special attention as identified by Owner. Indicate means for complying with Owner's requirements.

1.4 QUALITY ASSURANCE

A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

C. Accessible Temporary Egress: Comply with applicable provisions in related NC Existing Building Code.

1.5 PROJECT CONDITIONS

A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 PRODUCTS

2.1 MATERIALS

A. Polyethylene Sheet: Reinforced, fire-resistive sheet, 10-mil (0.25-mm) minimum thickness, with flame-spread rating of 15 or less in accordance with ASTM E84 and passing NFPA 701 Test Method 2.

B. Dust-Control Adhesive-Surface Walk-Off Mats: Provide mats, minimum 36 by 60 inches (914 by 1524 mm).

C. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

2.2 EQUIPMENT

A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
   1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
   2. Heating, Cooling, and Dehumidifying Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
   3. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return-air grille in system and remove at end of construction and clean HVAC system as required in Section 017700 "Closeout Procedures."

C. Air-Filtration Units: Primary and secondary HEPA-filter-equipped portable units with four-stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.

PART 3 EXECUTION

3.1 TEMPORARY FACILITIES, GENERAL

A. Conservation: Coordinate construction and use of temporary facilities with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
   1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

3.2 INSTALLATION, GENERAL

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
   1. Locate facilities to limit site disturbance as specified in Section 011000 "Summary."

B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

C. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.
   1. Maintain dust partitions during the Work. Use vacuum collection attachments on dust-producing equipment. Isolate limited work within occupied areas using portable dust-containment devices.
   2. Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.

3.3 TEMPORARY UTILITY INSTALLATION

A. General: Install temporary service or connect to existing service.
   1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.

C. Water Service:
   1. Install water service and distribution piping in sizes and pressures adequate for construction.
   2. Connect to Owner's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to Owner. At Final Acceptance, restore these facilities to condition existing before initial use.

D. Sanitary Facilities: Provide temporary toilets, wash facilities, safety shower and eyewash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
   1. Use of Permanent Toilets: Use of Owner's existing or new toilet facilities is not permitted. Utilities to be obtained and paid for directly by the Contractor: Toilet and sanitation facilities.

E. Temporary Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
   1. Provide temporary dehumidification systems when required to reduce ambient and substrate moisture levels to level required to allow installation or application of finishes and their proper curing or drying.

F. Electric Power Service:
   1. Only NCMA/DNCR Facility Operations is able to connect/disconnect to Owner's existing electric power service. Maintain equipment in a condition acceptable to Owner.

G. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
   1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

3.4 SUPPORT FACILITIES INSTALLATION

A. Temporary Use of Planned Permanent Roads and Paved Areas: Locate temporary roads and paved areas in same location as permanent roads and paved areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.
   1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
   2. Prepare subgrade and install subbase and base for temporary roads and paved areas in accordance with Section 312000 "Earth Moving."
   3. Recondition base after temporary use, including removing contaminated material, regrading, proofrolling, compacting, and testing.
   4. Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Final Acceptance. Repair hot-mix asphalt base-course pavement before installation of final course in accordance with Section 321216 "Asphalt Paving."

B. Traffic Controls: Comply with requirements of authorities having jurisdiction.
   1. Protect existing site improvements to remain, including curbs, pavement, and utilities.
   2. Maintain access for fire-fighting equipment and access to fire hydrants.

C. Parking: Use designated areas of Owner's existing parking areas for construction personnel.

D. Storage and Staging: Use designated areas of Project site for storage and staging needs.

E. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
   1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
   2. Remove snow and ice as required to minimize accumulations.

F. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.
   1. Identification Signs: Provide Project identification signs as indicated on Drawings.
   2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.
      a. Provide temporary, directional signs for construction personnel and visitors.
   3. Maintain and touch up signs, so they are legible at all times.

G. Waste Disposal Facilities:
   1. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."
   2. Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 017300 "Execution."

H. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
   1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

I. Existing Elevator Use: Use of Owner's existing elevators will be permitted, provided elevators are cleaned and maintained in a condition acceptable to Owner. At Final Acceptance, restore elevators to condition existing before initial use, including replacing worn cables, guide shoes, and similar items of limited life.
   1. Do not load elevators beyond their rated weight capacity.
   2. Provide protective coverings, barriers, devices, signs, or other procedures to protect elevator car and entrance doors and frame. If, despite such protection, elevators become damaged, engage elevator Installer to restore damaged work, so no evidence remains of correction work. Return items that cannot be refinished in field to the shop, make required repairs and refinish entire unit, or provide new units as required.

J. Existing Stair Usage: Use of Owner's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to Owner. At Final Acceptance, restore stairs to condition existing before initial use.
   1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas, so no evidence remains of correction work.

K. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Final Acceptance.

3.5 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.
   1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.

B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
   1. Comply with work restrictions specified in Section 011000 "Summary."

C. Temporary Erosion and Sedimentation Control:
   1. Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and

airborne dust to undisturbed areas and to adjacent properties and walkways, in accordance with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.

a. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree- or plant-protection zones.
b. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
c. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.
d. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

D. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.

E. Tree and Plant Protection:
1. Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.

F. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals, so Project will be free of pests and their residues at Final Acceptance. Perform control operations lawfully, using materials approved by authorities having jurisdiction.

G. Site Enclosure Fence: At every stage of construction, the Contractor shall furnish and install site enclosure fence/project area protection in a manner that will prevent people from easily entering active portion of construction operations except by entrance gates/doors.
1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.
2. Maintain security by limiting number of keys and restricting distribution to authorized personnel.

H. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock all building entrances at end of each workday.

I. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

J. Temporary Egress: Provide temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction. Provide signage directing occupants to temporary egress.

K. Covered Walkway: Erect protective, covered walkway for passage of individuals through or adjacent to Project site. Coordinate with entrance gates, other facilities, and obstructions. Comply with regulations of authorities having jurisdiction.
   1. Provide overhead decking, protective enclosure walls, handrails, barricades, warning signs, exit signs, lights, safe and well-drained walkways, and similar provisions for protection and safe passage.
   2. Paint and maintain appearance of walkway for duration of the Work.

L. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
   1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.

M. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Owner and tenants from fumes and noise.
   1. Construct dustproof partitions with two layers of 6-mil (0.14-mm) polyethylene sheet on each side. Cover floor with two layers of 6-mil (0.14-mm) polyethylene sheet, extending sheets 18 inches (460 mm) up the sidewalls. Overlap and tape full length of joints. Cover floor with fire-retardant-treated plywood.
      a. Construct vestibule and airlock at each entrance through temporary partition with not less than 48 inches (1219 mm) between doors. Maintain water-dampened foot mats in vestibule.
   2. Where fire-resistance-rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
   3. Insulate partitions to control noise transmission to occupied areas.
   4. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.
   5. Protect air-handling equipment.
   6. Provide walk-off mats at each entrance through temporary partition.

N. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.
   1. Prohibit smoking in construction areas. Comply with additional limits on smoking specified in other Sections.
   2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition in accordance with requirements of authorities having jurisdiction.
   3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
   4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign, stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.6 MOISTURE AND MOLD CONTROL

A. Moisture and Mold Protection: Protect stored materials and installed Work in accordance with

Moisture and Mold Protection Plan.

B. Exposed Construction Period: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:
   1. Protect porous materials from water damage.
   2. Protect stored and installed material from flowing or standing water.
   3. Keep porous and organic materials from coming into prolonged contact with concrete.
   4. Remove standing water from decks.
   5. Keep deck openings covered or dammed.

C. Partially Enclosed Construction Period: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:
   1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
   2. Keep interior spaces reasonably clean and protected from water damage.
   3. Periodically collect and remove waste containing cellulose or other organic matter.
   4. Discard or replace water-damaged material.
   5. Do not install material that is wet.
   6. Discard and replace stored or installed material that begins to grow mold.
   7. Perform work in a sequence that allows wet materials adequate time to dry before enclosing the material in gypsum board or other interior finishes.

D. Controlled Construction Period: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:
   1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
   2. Use temporary or permanent HVAC system to control humidity within ranges specified for installed and stored materials.
   3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.
      a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for 48 hours are considered defective and require replacing.
      b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for 48 hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Architect.
      c. Remove and replace materials that cannot be completely restored to their manufactured moisture level within 48 hours.

3.7 OPERATION, TERMINATION, AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

B. Maintenance: Maintain facilities in good operating condition until removal.
   1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated

results and to avoid possibility of damage.

C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Final Acceptance.

D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Final Acceptance. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
   1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
   2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
   3. At Final Acceptance, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

END OF SECTION 015000

SECTION 015639 - TEMPORARY TREE AND PLANT PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section Includes: General protection and pruning of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction.

B. Related Requirements:
   1. Section 311000 "Site Clearing" for removing existing trees and shrubs and for temporary erosion- and sedimentation-control measures if not specified in Section 015000 "Temporary Facilities and Controls".

1.2 DEFINITIONS

A. Caliper: Diameter of a trunk measured by a diameter tape at a height 6 inches above the ground for trees up to and including 4-inch size at this height and as measured at a height of 12 inches above the ground for trees larger than 4-inch size.

B. Caliper (DBH): Diameter breast height; diameter of a trunk as measured by a diameter tape at a height 54 inches above the ground line for trees with caliper of 8 inches or greater as measured at a height of 12 inches above the ground.

C. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.

D. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and indicated on Drawings.

E. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

   1. Review methods and procedures related to temporary tree and plant protection including, but not limited to, the following:

      a. Tree-service firm's personnel and equipment needed to make progress and avoid delays.
      b. Arborist's responsibilities.
      c. Quality-control program.
      d. Coordination of Work and equipment movement with the locations of protection zones.
      e. Trenching by hand or with air spade within protection zones.

f. Field quality control.

1.4 ACTION SUBMITTALS

A. Product Data:

1. General protection of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction

B. Samples: For each type of the following:

1. Organic Mulch: 1-quart volume of organic mulch; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch.
2. Protection-Zone Fencing: Assembled Samples of manufacturer's standard size made from full-size components.
3. Protection-Zone Signage: Full-size Samples of each size and text, ready for installation.

C. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the Work.

D. Mitigation Requirements: As required by jurisdiction or as developed by arborist, for mitigation of damage to trees and other plantings. Include the following:

1. Local ordinances governing tree mitigation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For arborist and tree service firm.

B. Certification: From arborist, certifying that trees indicated to remain have been protected during construction in accordance with recognized standards and that trees were promptly and properly treated and repaired when damaged.

C. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the Work.

1.6 QUALITY ASSURANCE

A. Arborist Qualifications: Licensed master arborist in jurisdiction where Project is located.

1.7 FIELD CONDITIONS

A. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Moving or parking vehicles or equipment.
3. Foot traffic.

4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

B. Do not direct vehicle or equipment exhaust toward protection zones.

C. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones and organic mulch.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Protection-Zone Fencing: As shown on Drawings.

B. Protection-Zone Signage: Shop-fabricated, rigid plastic or metal sheet with attachment holes prepunched and reinforced; legibly printed with nonfading lettering and as follows:

1. Size and Text: As indicated on Drawings.
2. Lettering: 3-inch-high minimum, black characters on white background.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

B. Prepare written report, endorsed by arborist, listing conditions detrimental to tree and plant protection.

3.2 PREPARATION

A. Locate and clearly identify trees, shrubs, and other vegetation to remain.

B. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.

3.3 TREE PROTECTION

A. Tree-Protection Zones: Mulch areas inside tree-protection zones and other areas indicated. Do not exceed indicated thickness of mulch.

1. Apply 2-inch uniform thickness of organic mulch unless otherwise indicated. Do not place mulch within 6 inches of tree trunks.
2. Install temporary root-protection matting over mulch to the extent indicated.

3.4 PROTECTION ZONES

A. Protection-Zone Fencing: Install protection-zone fencing along edges of protection zones before materials or equipment are brought on the site and construction operations begin in a manner that will prevent people and animals from easily entering protected areas except by entrance gates. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections where fencing is located adjacent to pedestrian walkways or in close proximity to street intersections, drives, or other vehicular circulation.

1. Chain-Link Fencing: Install to comply with ASTM F567 and with manufacturer's written instructions.
2. Posts: Set or drive posts into ground one-third the total height of the fence without concrete footings. Where a post is located on existing paving or concrete to remain, provide appropriate means of post support acceptable to Architect.
3. Access Gates: Install with direction from Arborist or Landscape Architect; adjust to operate smoothly, easily, and quietly; free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Protection-Zone Signage: Install protection-zone signage in visibly prominent locations in a manner approved by Landscape Architect. Install one sign spaced approximately every 50 ft. on protection-zone fencing, but no fewer than four signs with each facing a different direction.

C. Maintain protection zones free of weeds and trash.

D. Maintain hydration of plants to assure plant survival.

E. Maintain protection-zone fencing and signage in good condition as acceptable to Architect and remove when construction operations are complete and equipment has been removed from the site.

1. Do not remove protection-zone fencing, even temporarily, to allow deliveries or equipment access through the protection zone.
2. Temporary access is permitted subject to preapproval in writing by arborist if a root buffer effective against soil compaction is constructed as directed by arborist. Maintain root buffer so long as access is permitted.

3.5 EXCAVATION

A. General: Excavate at edge of protection zones and for trenches indicated within protection zones in accordance with requirements in Section 312000 "Earth Moving" unless otherwise indicated.

B. Trenching within Protection Zones: Where utility trenches are required within protection zones, excavate under or around tree roots by hand or with air spade, or tunnel under the roots by drilling, auger boring, or pipe jacking. Do not cut main lateral tree roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots as required for root pruning. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots.

3.6 ROOT PRUNING

A. Prune tree roots that are affected by temporary and permanent construction. Prune roots as follows:

1. Excavate and cut roots by hand by digging a trench and cutting exposed roots with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
2. Cut Ends: Do not paint cut root ends.
3. Temporarily support and protect roots from damage until they are permanently covered with soil.
4. Cover exposed roots with burlap and water regularly.
5. Backfill as soon as possible in accordance with requirements in Section 312000 "Earth Moving."

B. Root Pruning at Edge of Protection Zone: Prune tree roots 12 inches outside of the protection zone by cleanly cutting all roots to the depth of the required excavation.

C. Root Pruning within Protection Zone: Clear and excavate by hand or with air spade to the depth of the required excavation to minimize damage to tree root systems. If excavating by hand, use narrow-tine spading forks to comb soil to expose roots. Cleanly cut roots as close to excavation as possible.

3.7 REGRADING

A. Lowering Grade: Where new finish grade is indicated below existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.

B. Lowering Grade within Protection Zone: Where new finish grade is indicated below existing grade around trees, slope grade away from trees as recommended by arborist unless otherwise indicated.

1. Root Pruning: Prune tree roots exposed by lowering the grade. Do not cut main lateral roots or taproots; cut only smaller roots. Cut roots as required for root pruning.

C. Raising Grade: Where new finish grade is indicated above existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.

D. Minor Fill within Protection Zone: Where existing grade is 2 inches or less below elevation of finish grade, fill with backfill soil. Place backfill soil in a single uncompacted layer and hand grade to required finish elevations.

3.8 FIELD QUALITY CONTROL

A. Inspections: Engage a qualified arborist to direct plant-protection measures in the vicinity of trees, shrubs, and other vegetation indicated to remain and to prepare inspection reports.

3.9 REPAIR AND REPLACEMENT

A. General: Repair or replace trees, shrubs, and other vegetation indicated to remain or to be relocated that are damaged by construction operations, in a manner approved by Landscape Architect.

END OF SECTION 015639

SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.

B. Related Requirements:
   1. Section 012500 "Substitution Procedures" for requests for substitutions.
   2. Section 014200 "References" for applicable industry standards for products specified.

1.3 DEFINITIONS

A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
   1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
   2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
   3. Comparable Product: Product that is demonstrated and approved by Architect through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Basis-of-Design Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. In addition to the basis-of-design product description, product attributes and characteristics may be listed to establish the significant qualities related to type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification.

C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section,

provide products qualified under the specified product procedure. In the event that a named product or product by a named manufacturer does not meet the other requirements of the specifications, select another named product or product from another named manufacturer that does meet the requirements of the specifications. Submit a comparable product request, if applicable.

1.4 ACTION SUBMITTALS

A. Comparable Product Request Submittal: Submit request for consideration of each comparable product. Identify basis-of-design product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
   1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
   2. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a comparable product request. Architect will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
      a. Form of Architect's Approval of Submittal: As specified in Section 013300 "Submittal Procedures."
      b. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.

B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 013300 "Submittal Procedures." Show compliance with requirements.

1.5 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.
   1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
   2. If a dispute arises between contractors over concurrently selectable but incompatible products, Architect will determine which products shall be used.

B. Identification of Products: Except for required labels and operating data, do not attach or imprint manufacturer or product names or trademarks on exposed surfaces of products or equipment that will be exposed to view in occupied spaces or on the exterior.
   1. Labels: Locate required product labels and stamps on a concealed surface, or, where required for observation following installation, on a visually accessible surface that is not conspicuous.
   2. Equipment Nameplates: Provide a permanent nameplate on each item of service-connected or power-operated equipment. Locate on a visually accessible but inconspicuous surface. Include information essential for operation, including the following:
      a. Name of product and manufacturer.

b. Model and serial number.
c. Capacity.
d. Speed.
e. Ratings.

3. See individual identification sections in Divisions 21, 22, 23, and 26 for additional identification requirements.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

B. Delivery and Handling:
1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

C. Storage:
1. Store products to allow for inspection and measurement of quantity or counting of units.
2. Store materials in a manner that will not endanger Project structure.
3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
6. Protect stored products from damage and liquids from freezing.
7. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.7 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
2. Special Warranty: Written warranty required by the Contract Documents to provide

specific rights for Owner.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
   1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
   2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
   3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time: Comply with requirements in Section 017700 "Closeout Procedures."

PART 2 PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
   1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
   2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
   3. Owner reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
   4. Where products are accompanied by the term "as selected," Architect will make selection.
   5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
   6. Or Equal: For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.
      a. Submit additional documentation required by Architect in order to establish equivalency of proposed products. Evaluation of "or equal" product status is by the Architect whose determination is final.

B. Product Selection Procedures:
   1. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.
      a. Limited list of products may be indicated by the phrase: "Subject to compliance with requirements, provide one of the following: …."
   2. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, which complies with requirements.
      a. Non-limited list of products is indicated by the phrase: "Subject to compliance with requirements, available products that may be incorporated in the Work include, but

are not limited to, the following: …."

3. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.
    a. Limited list of manufacturers is indicated by the phrase: "Subject to compliance with requirements, provide products by one of the following: …."
4. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, which complies with requirements.
    a. Non-limited list of manufacturers is indicated by the phrase: "Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following: …."
5. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
    a. For approval of products by unnamed manufacturers, comply with requirements in Section 012500 "Substitution Procedures" for substitutions for convenience.

2.2 COMPARABLE PRODUCTS

A. Conditions for Consideration of Comparable Products: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with these requirements:
    1. Evidence that proposed product does not require revisions to the Contract Documents, is consistent with the Contract Documents, will produce the indicated results, and is compatible with other portions of the Work. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant product qualities include attributes such as type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other specific features and requirements.
    2. Evidence that proposed product provides specified warranty.
    3. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
    4. Samples, if requested.

B. Submittal Requirements: Approval by the Architect of Contractor's request for use of comparable product is not intended to satisfy other submittal requirements. Comply with specified submittal requirements.

PART 3 EXECUTION - NOT USED

END OF SECTION 016000

SECTION 017300 - EXECUTION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:
   1. Construction layout.
   2. Field engineering and surveying.
   3. Installation of the Work.
   4. Cutting and patching.
   5. Coordination of Owner-installed products.
   6. Progress cleaning.
   7. Starting and adjusting.
   8. Protection of installed construction.

B. Related Requirements:
   1. Section 011000 "Summary" for limits on use of Project site.
   2. Section 013300 "Submittal Procedures" for submitting surveys.

1.3 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.

B. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.

1.4 PREINSTALLATION MEETINGS

A. Cutting and Patching Conference: Conduct conference at Project site.
   1. Prior to commencing work requiring cutting and patching, review extent of cutting and patching anticipated and examine procedures for ensuring satisfactory result from cutting and patching work. Require representatives of each entity directly concerned with cutting and patching to attend, including the following:
      a. Contractor's superintendent.
      b. Trade supervisor responsible for cutting operations.
      c. Trade supervisor(s) responsible for patching of each type of substrate.

d. Mechanical, electrical, and utilities subcontractors' supervisors, to the extent each trade is affecting by cutting and patching operations.

2. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For land surveyor.

B. Certificates: Submit certificate signed by land surveyor certifying that location and elevation of improvements comply with requirements.

1.6 QUALITY ASSURANCE

A. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.

1. Structural Elements: When cutting and patching structural elements, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operational elements include the following:
   a. Primary operational systems and equipment.
   b. Fire separation assemblies.
   c. Air or smoke barriers.
   d. Plumbing piping systems.
   e. Mechanical systems piping and ducts.
   f. Control systems.
   g. Communication systems.
   h. Fire-detection and -alarm systems.
   i. Electrical wiring systems.
   j. Operating systems of special construction.
3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Other construction elements include but are not limited to the following:
   a. Water, moisture, or vapor barriers.
   b. Membranes and flashings.
   c. Exterior curtain-wall construction.
   d. Sprayed fire-resistive material.
   e. Equipment supports.
   f. Piping, ductwork, vessels, and equipment.
   g. Noise- and vibration-control elements and systems.

4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

B. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

PART 2 PRODUCTS

2.1 MATERIALS

A. General: Comply with requirements specified in other Sections.
1. For projects requiring compliance with sustainable design and construction practices and procedures, use products for patching that comply with sustainable design requirements.

B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

B. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
1. Description of the Work.
2. List of detrimental conditions, including substrates.
3. List of unacceptable installation tolerances.
4. Recommended corrections.

C. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Existing Utility Information: Furnish information to local utility that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Architect according to requirements in Section 013100 "Project Management and Coordination."

3.3 CONSTRUCTION LAYOUT

A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect promptly.

B. General: Engage a land surveyor to lay out the Work using accepted surveying practices.
1. Establish limits on use of Project site.
2. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
3. Inform installers of lines and levels to which they must comply.
4. Check the location, level and plumb, of every major element as the Work progresses.
5. Notify Architect when deviations from required lines and levels exceed allowable tolerances.
6. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.

C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.

D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.

E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log

available for reference by Architect.

3.4 FIELD ENGINEERING

A. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
   1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect before proceeding.
   2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.

B. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
   1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
   2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
   3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.

3.5 INSTALLATION

A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
   1. Make vertical work plumb and make horizontal work level.
   2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
   3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
   4. Maintain minimum headroom clearance of 96 inches in occupied spaces and 90 inches in unoccupied spaces.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Final Acceptance.

D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.

F. Tools and Equipment: Where possible, select tools or equipment that minimize production of excessive noise levels.

G. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other portions of the Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.
   1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
   2. Allow for building movement, including thermal expansion and contraction.
   3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

I. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.

J. Repair or remove and replace damaged, defective, or nonconforming Work.
   1. Comply with Section 017700 "Closeout Procedures" for repairing or removing and replacing defective Work.

3.6 CUTTING AND PATCHING

A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
   1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.

C. Temporary Support: Provide temporary support of work to be cut.

D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

E. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching according to requirements in Section 011000 "Summary."

F. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.

G. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
   1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
   2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
   3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
   4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
   5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
   6. Proceed with patching after construction operations requiring cutting are complete.

H. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.
   1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
   2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.
      a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
      b. Restore damaged pipe covering to its original condition.
   3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
      a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
   4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
   5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.

I. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.7 OWNER-INSTALLED PRODUCTS

A. Site Access: Provide access to Project site for Owner's construction personnel.

B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction personnel.
   1. Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.
   2. Preinstallation Conferences: Include Owner's construction personnel at preinstallation conferences covering portions of the Work that are to receive Owner's work. Attend preinstallation conferences conducted by Owner's construction personnel if portions of the Work depend on Owner's construction.

3.8 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
   1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
   2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F.
   3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
      a. Use containers intended for holding waste materials of type to be stored.
   4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.

B. Site: Maintain Project site free of waste materials and debris.

C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
   1. Remove liquid spills promptly.
   2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Final Acceptance.

G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials

down sewers or into waterways. Comply with waste disposal requirements in Section 017419 "Construction Waste Management and Disposal."

H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Final Acceptance.

I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

J. Limiting Exposures: Supervise construction operations to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.9 STARTING AND ADJUSTING

A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

B. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.

C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Manufacturer's Field Service: Comply with qualification requirements in Section 014000 "Quality Requirements."

3.10 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Final Acceptance.

B. Protection of Existing Items: Provide protection and ensure that existing items to remain undisturbed by construction are maintained in condition that existed at commencement of the Work.

C. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION 017300

SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for the following:
   1. Recycling nonhazardous construction waste.
   2. Disposing of nonhazardous construction waste.

B. Related Requirements:
   1. Section 042000 "Unit Masonry" for disposal requirements for masonry waste.

1.3 DEFINITIONS

A. Construction Waste: Building, structure, and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.

B. Disposal: Removal of demolition or construction waste and subsequent salvage, sale, recycling, or deposit in landfill, incinerator acceptable to authorities having jurisdiction, or designated spoil areas on Owner’s property.

C. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

D. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.

E. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.4 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition and construction waste become property of Contractor.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with transportation and disposal regulations of authorities having jurisdiction.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 RECYCLING AND CONSTRUCTION WASTE, GENERAL

A. General: Recycle paper and beverage containers used by on-site workers.

B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall be shared equally by Owner and Contractor.

C. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.

D. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.
   1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
      a. Inspect containers and bins for contamination and remove contaminated materials if found.
   2. Remove recyclable waste from Owner's property and transport to recycling receiver or processor as often as required to prevent overfilling bins.

3.2 RECYCLING CONSTRUCTION WASTE

A. Packaging:
   1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
   2. Polystyrene Packaging: Separate and bag materials.
   3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
   4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

B. Wood Materials:
   1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
   2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.

C. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location.
   1. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.

D. Paint: Seal containers and store by type.

3.3 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged or recycled, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
   1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
   2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn waste materials.

END OF SECTION 017419

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
   1. Final completion procedures.
   2. Warranties.
   3. Final cleaning.
   4. Repair of the Work.

B. Related Requirements:
   1. Section 013233 "Photographic Documentation" for submitting final completion construction photographic documentation.
   2. Section 017823 "Operation and Maintenance Data" for additional operation and maintenance manual requirements.
   3. Section 017839 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
   4. Section 017900 "Demonstration and Training" for requirements to train the Owner's maintenance personnel to adjust, operate, and maintain products, equipment, and systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of cleaning agent.

B. Contractor's List of Incomplete Items: Initial submittal at Final Acceptance.

C. Certified List of Incomplete Items: Final submittal at final completion.

1.4 CLOSEOUT SUBMITTALS

A. Certificates of Release: From authorities having jurisdiction.

B. Certificate of Insurance: For continuing coverage.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Schedule of Maintenance Material Items: For maintenance material submittal items specified in other Sections.

1.6 FINAL COMPLETION PROCEDURES

A. Submittals Prior to Final Completion: Before requesting final inspection for determining final completion, complete the following:
   1. Submit a final Application for Payment according to Section 012900 "Payment Procedures."
   2. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
   3. Submit final completion photographic documentation.

1.7 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
   1. Organize list of spaces in sequential order, starting with exterior areas first.
   2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
   3. Include the following information at the top of each page:
      a. Project name.
      b. Date.
      c. Name of Architect and Construction Manager.
      d. Name of Contractor.
      e. Page number.
   4. Submit list of incomplete items in one of the following format:
      a. MS Excel electronic file. Architect, through Construction Manager, will return annotated file.
      b. PDF electronic file. Architect, through Construction Manager, will return annotated file.
      c. Web-based project software upload. Utilize software feature for creating and updating list of incomplete items (punch list).

1.8 SUBMITTAL OF PROJECT WARRANTIES

A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where warranties are indicated to commence on dates other than date of Final Acceptance, or when delay in submittal of warranties might limit Owner's rights under warranty.

B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.

C. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.

D. Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
   1. Submit on digital media acceptable to Architect by uploading to web-based project software site.

E. Warranties in Paper Form:
   1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
   2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
   3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.

F. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 EXECUTION

3.1 FINAL CLEANING

A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

C. Construction Waste Disposal: Comply with waste disposal requirements in Section 017419 "Construction Waste Management and Disposal."

3.2 REPAIR OF THE WORK

A. Complete repair and restoration operations before requesting inspection for determination of Final Acceptance.

B. Repair, or remove and replace, defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.
   1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
   2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that that already show evidence of repair or restoration.
      a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
   3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
   4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

END OF SECTION 017700

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
   1. Operation and maintenance documentation directory manuals.
   2. Emergency manuals.
   3. Systems and equipment operation manuals.
   4. Systems and equipment maintenance manuals.
   5. Product maintenance manuals.

B. Related Requirements:
   1. Section 013300 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.

1.3 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 CLOSEOUT SUBMITTALS

A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
   1. Architect and Commissioning Authority will comment on whether content of operation and maintenance submittals is acceptable.
   2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

B. Format: Submit operation and maintenance manuals in the following format:
   1. Submit on digital media acceptable to Architect by uploading to web-based project software site. Enable reviewer comments on draft submittals.
   2. Submit three paper copies. Architect, through Construction Manager, will return two copies.

C. Initial Manual Submittal: Submit draft copy of each manual at least 30 days before commencing demonstration and training. Architect and Commissioning Authority will comment on whether general scope and content of manual are acceptable.

D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Final Acceptance and at least 15 days before commencing demonstration and training. Architect and Commissioning Authority will return copy with comments.
   1. Correct or revise each manual to comply with Architect's and Commissioning Authority's comments. Submit copies of each corrected manual within 15 days of receipt of Architect's and Commissioning Authority's comments and prior to commencing demonstration and training.

E. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

1.5 FORMAT OF OPERATION AND MAINTENANCE MANUALS

A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
   1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
   2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

B. Manuals, Paper Copy: Submit manuals in the form of hard-copy, bound and labeled volumes.
   1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
      a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
      b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.

2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment. Enclose title pages and directories in clear plastic sleeves.
4. Supplementary Prepared on 8-1/2-by-11-inch white bond paper.
5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
    a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
    b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

1.6 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
    1. Title page.
    2. Table of contents.
    3. Manual contents.

B. Title Page: Include the following information:
    1. Subject matter included in manual.
    2. Name and address of Project.
    3. Name and address of Owner.
    4. Date of submittal.
    5. Name and contact information for Contractor.
    6. Name and contact information for Construction Manager.
    7. Name and contact information for Architect.
    8. Name and contact information for Commissioning Authority.
    9. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
    10. Cross-reference to related systems in other operation and maintenance manuals.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
    1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

1.7 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY MANUAL

A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals. List items and their location to facilitate ready access to desired information. Include the following:
   1. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
   2. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
   3. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

1.8 EMERGENCY MANUALS

A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.

B. Content: Organize manual into a separate section for each of the following:
   1. Type of emergency.
   2. Emergency instructions.
   3. Emergency procedures.

C. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
   1. Fire.
   2. Flood.
   3. Gas leak.
   4. Water leak.
   5. Power failure.
   6. Water outage.
   7. System, subsystem, or equipment failure.
   8. Chemical release or spill.

D. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

E. Emergency Procedures: Include the following, as applicable:
   1. Instructions on stopping.
   2. Shutdown instructions for each type of emergency.
   3. Operating instructions for conditions outside normal operating limits.

4. Required sequences for electric or electronic systems.
5. Special operating instructions and procedures.

1.9 SYSTEMS AND EQUIPMENT OPERATION MANUALS

A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.
   1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
   2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
   1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
   2. Performance and design criteria if Contractor has delegated design responsibility.
   3. Operating standards.
   4. Operating procedures.
   5. Operating logs.
   6. Wiring diagrams.
   7. Control diagrams.
   8. Piped system diagrams.
   9. Precautions against improper use.
   10. License requirements including inspection and renewal dates.

C. Descriptions: Include the following:
   1. Product name and model number. Use designations for products indicated on Contract Documents.
   2. Manufacturer's name.
   3. Equipment identification with serial number of each component.
   4. Equipment function.
   5. Operating characteristics.
   6. Limiting conditions.
   7. Performance curves.
   8. Engineering data and tests.
   9. Complete nomenclature and number of replacement parts.

D. Operating Procedures: Include the following, as applicable:
   1. Startup procedures.
   2. Equipment or system break-in procedures.
   3. Routine and normal operating instructions.
   4. Regulation and control procedures.
   5. Instructions on stopping.
   6. Normal shutdown instructions.
   7. Seasonal and weekend operating instructions.

8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

F. Piped Systems: Diagram piping as installed, and identify color coding where required for identification.

1.10 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.
   1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
   2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds as described below.

C. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:
   1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
      a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
   2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
   3. Identification and nomenclature of parts and components.
   4. List of items recommended to be stocked as spare parts.

E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
   1. Test and inspection instructions.
   2. Troubleshooting guide.
   3. Precautions against improper maintenance.
   4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
   5. Aligning, adjusting, and checking instructions.
   6. Demonstration and training video recording, if available.

F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
   1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
   2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

G. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

H. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

I. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
   1. Include procedures to follow and required notifications for warranty claims.

J. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
   1. Do not use original project record documents as part of maintenance manuals.

1.11 PRODUCT MAINTENANCE MANUALS

A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

C. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Product Information: Include the following, as applicable:
   1. Product name and model number.
   2. Manufacturer's name.
   3. Color, pattern, and texture.
   4. Material and chemical composition.
   5. Reordering information for specially manufactured products.

E. Maintenance Procedures: Include manufacturer's written recommendations and the following:
   1. Inspection procedures.
   2. Types of cleaning agents to be used and methods of cleaning.
   3. List of cleaning agents and methods of cleaning detrimental to product.
   4. Schedule for routine cleaning and maintenance.
   5. Repair instructions.

F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
   1. Include procedures to follow and required notifications for warranty claims.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 017823

SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for project record documents, including the following:
   1. Record Drawings.
   2. Record Specifications.
   3. Record Product Data.
   4. Miscellaneous record submittals.

B. Related Requirements:
   1. Section 017300 "Execution" for final property survey.
   2. Section 017700 "Closeout Procedures" for general closeout procedures.
   3. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.3 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:
   1. Number of Copies: Submit one set(s) of marked-up record prints.
   2. Number of Copies: Submit copies of record Drawings as follows:
      a. Initial Submittal:
         1) Submit one paper-copy set(s) of marked-up record prints.
         2) Submit PDF electronic files of scanned record prints and one of file print, facilitated by using Procore (Construction Document Management System).
         3) Architect will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.

B. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.

C. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.
   1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.

D. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities.

Submit annotated PDF electronic files and directories of each submittal.

E. Reports: Submit written report weekly indicating items incorporated into project record documents concurrent with progress of the Work, including revisions, concealed conditions, field changes, product selections, and other notations incorporated.

1.4 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
   1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
      a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
      b. Accurately record information in an acceptable drawing technique.
      c. Record data as soon as possible after obtaining it.
      d. Record and check the markup before enclosing concealed installations.
      e. Cross-reference record prints to corresponding photographic documentation.
   2. Content: Types of items requiring marking include, but are not limited to, the following:
      a. Dimensional changes to Drawings.
      b. Revisions to details shown on Drawings.
      c. Depths of foundations.
      d. Locations and depths of underground utilities.
      e. Revisions to routing of piping and conduits.
      f. Revisions to electrical circuitry.
      g. Actual equipment locations.
      h. Duct size and routing.
      i. Locations of concealed internal utilities.
      j. Changes made by Change Order or Construction Change Directive.
      k. Changes made following Architect's written orders.
      l. Details not on the original Contract Drawings.
      m. Field records for variable and concealed conditions.
      n. Record information on the Work that is shown only schematically.
   3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
   4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
   5. Mark important additional information that was either shown schematically or omitted from original Drawings.
   6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
   1. Record Prints: Organize record prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
   2. Format: Annotated PDF electronic file.
   3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
   4. Identification: As follows:
      a. Project name.
      b. Date.
      c. Designation "PROJECT RECORD DRAWINGS."
      d. Name of Architect and Construction Manager.
      e. Name of Contractor.

1.5 RECORD SPECIFICATIONS

A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
   1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
   2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
   3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
   4. For each principal product, indicate whether record Product Data has been submitted in operation and maintenance manuals instead of submitted as record Product Data.
   5. Note related Change Orders, record Product Data, and record Drawings where applicable.

B. Format: Submit record Specifications as annotated PDF electronic file.

1.6 RECORD PRODUCT DATA

A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.

B. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
   1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
   2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
   3. Note related Change Orders, record Specifications, and record Drawings where applicable.

C. Format: Submit record Product Data as annotated PDF electronic file.
   1. Include record Product Data directory organized by Specification Section number and title, electronically linked to each item of record Product Data.

1.7 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

B. Format: Submit miscellaneous record submittals as PDF electronic file.
   1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

1.8 MAINTENANCE OF RECORD DOCUMENTS

A. Maintenance of Record Documents: Store record documents in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Architect's and Construction Manager's reference during normal working hours.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 017839

SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
   1. Instruction in operation and maintenance of systems, subsystems, and equipment.
   2. Demonstration and training video recordings.

1.3 INFORMATIONAL SUBMITTALS

A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
   1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.

B. Qualification Data: For facilitator.

C. Attendance Record: For each training module, submit list of participants and length of instruction time.

D. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

1.4 CLOSEOUT SUBMITTALS

A. Demonstration and Training Video Recordings: Submit two copies within seven days of end of each training module.
   1. Identification: On each copy, provide an applied label with the following information:
      a. Name of Project.
      b. Name and address of videographer.
      c. Name of Architect.
      d. Name of Construction Manager.
      e. Name of Contractor.

f. Date of video recording.

2. Transcript: Prepared and bound in format matching operation and maintenance manuals. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding video recording. Include name of Project and date of video recording on each page.
3. Transcript: Prepared in PDF electronic format. Include a cover sheet with same label information as the corresponding video recording and a table of contents with links to corresponding training components. Include name of Project and date of video recording on each page.
4. At completion of training, submit complete training manual(s) for Owner's use prepared in same PDF file format required for operation and maintenance manuals specified in Section 017823 "Operation and Maintenance Data."

1.5 QUALITY ASSURANCE

A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.

B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 014000 "Quality Requirements," experienced in operation and maintenance procedures and training.

C. Videographer Qualifications: A professional videographer who is experienced photographing demonstration and training events similar to those required.

D. Pre-instruction Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to demonstration and training including, but not limited to, the following:
   1. Inspect and discuss locations and other facilities required for instruction.
   2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
   3. Review required content of instruction.
   4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.6 COORDINATION

A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.

B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data have been reviewed and approved by Architect.

1.7 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
   1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
      a. System, subsystem, and equipment descriptions.
      b. Performance and design criteria if Contractor is delegated design responsibility.
      c. Operating standards.
      d. Regulatory requirements.
      e. Equipment function.
      f. Operating characteristics.
      g. Limiting conditions.
      h. Performance curves.
   2. Documentation: Review the following items in detail:
      a. Emergency manuals.
      b. Systems and equipment operation manuals.
      c. Systems and equipment maintenance manuals.
      d. Product maintenance manuals.
      e. Project Record Documents.
      f. Identification systems.
      g. Warranties and bonds.
      h. Maintenance service agreements and similar continuing commitments.
   3. Emergencies: Include the following, as applicable:
      a. Instructions on meaning of warnings, trouble indications, and error messages.
      b. Instructions on stopping.
      c. Shutdown instructions for each type of emergency.
      d. Operating instructions for conditions outside of normal operating limits.
      e. Sequences for electric or electronic systems.
      f. Special operating instructions and procedures.
   4. Operations: Include the following, as applicable:
      a. Startup procedures.
      b. Equipment or system break-in procedures.
      c. Routine and normal operating instructions.
      d. Regulation and control procedures.
      e. Control sequences.
      f. Safety procedures.
      g. Instructions on stopping.
      h. Normal shutdown instructions.
      i. Operating procedures for emergencies.
      j. Operating procedures for system, subsystem, or equipment failure.
      k. Seasonal and weekend operating instructions.
      l. Required sequences for electric or electronic systems.
      m. Special operating instructions and procedures.

5. Adjustments: Include the following:
   a. Alignments.
   b. Checking adjustments.
   c. Noise and vibration adjustments.
   d. Economy and efficiency adjustments.
6. Troubleshooting: Include the following:
   a. Diagnostic instructions.
   b. Test and inspection procedures.
7. Maintenance: Include the following:
   a. Inspection procedures.
   b. Types of cleaning agents to be used and methods of cleaning.
   c. List of cleaning agents and methods of cleaning detrimental to product.
   d. Procedures for routine cleaning.
   e. Procedures for preventive maintenance.
   f. Procedures for routine maintenance.
   g. Instruction on use of special tools.
8. Repairs: Include the following:
   a. Diagnosis instructions.
   b. Repair instructions.
   c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
   d. Instructions for identifying parts and components.
   e. Review of spare parts needed for operation and maintenance.

1.8 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 "Operation and Maintenance Data."

B. Set up instructional equipment at instruction location.

1.9 INSTRUCTION

A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.

B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
   1. Architect will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
   2. Owner will furnish an instructor to describe Owner's operational philosophy.
   3. Owner will furnish Contractor with names and positions of participants.

C. Scheduling: Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
   1. Schedule training with Owner, through Construction Manager, with at least seven days' advance notice.

D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

E. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

1.10 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

A. General: Engage a qualified commercial videographer to record demonstration and training video recordings. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.
   1. At beginning of each training module, record each chart containing learning objective and lesson outline.

B. Digital Video Recordings: Provide high-resolution, digital video in MPEG format, produced by a digital camera with minimum sensor resolution of 12 megapixels and capable of recording in full HD modewith vibration reduction technology.
   1. Submit video recordings on CD-ROM or thumb drive.
   2. File Hierarchy: Organize folder structure and file locations according to Project Manual table of contents. Provide complete screen-based menu.
   3. File Names: Utilize file names based on name of equipment generally described in video segment, as identified in Project specifications.
   4. Contractor and Installer Contact File: Using appropriate software, create a file for inclusion on the equipment demonstration and training recording that describes the following for each Contractor involved on the Project, arranged according to Project Manual table of contents:
      a. Name of Contractor/Installer.
      b. Business address.
      c. Business phone number.
      d. Point of contact.
      e. Email address.

C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to adequately cover area of demonstration and training. Display continuous running time.
   1. Film training session(s) in segments not to exceed 15 minutes.
      a. Produce segments to present a single significant piece of equipment per segment.
      b. Organize segments with multiple pieces of equipment to follow order of Project Manual table of contents.
      c. Where a training session on a particular piece of equipment exceeds 15 minutes, stop filming and pause training session. Begin training session again upon commencement of new filming segment.

D. Light Levels: Verify light levels are adequate to properly light equipment. Verify equipment markings are clearly visible prior to recording.
   1. Furnish additional portable lighting as required.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 017900

SECTION 01 9113 – GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. Divisions 23 and 26

1.2 DESCRIPTION

A. This Division covers the general provisions for the commissioning of mechanical and lighting systems.

B. Commissioning is the systematic process of ensuring that building systems perform interactively according to the Owner’s project requirements and the operational requirements specified in other Divisions. The Commissioning Authority shall oversee and coordinate equipment start-up, system performance, testing, adjusting, and balancing, control system calibration, construction and system documentation, and Owner training.

C. Specific requirements of the commissioning process and responsibilities, duties, and obligations of the Commissioning Authority are described in the Section. To accomplish these duties, the Commissioning Authority shall coordinate his activities with other entities.

1.3 REFERENCES

A. ASHRAE Guideline 0-2005, The Commissioning Process

B. ASHRAE Standard 202, Commissioning for Buildings and Systems

C. ASHRAE Guideline 1-2007, The HVAC Commissioning Process

D. ASHRAE Guideline 4-1993, Preparation of Operating and Maintenance Documentation for Building Systems

E. ASHRAE Guideline 1.1, HVAC&R Technical Requirements for the Commissioning Process

1.4 DEFINITIONS

A. The following terms are used in this Section:

1. Acceptance phase - phase of construction after initial start-up and check-out when functional testing, operational training, and operating and maintenance documentation development and review occurs.
2. Basis of design (BOD) - the documentation of the primary thought processes and assumptions behind design decisions that were made to meet the Owner's project requirements.
   The basis of design describes the intent of the project and the systems, components, conditions, and methods chosen to meet the Owner's project requirements.
3. Commissioning Authority (CxA)
4. Commissioning Plan - an overall plan that provides the structure, schedule, and coordination planning for the commissioning process.
5. Commissioning team - the group responsible for accomplishing the commissioning process.

6. Data logging - monitoring flows, currents, status, and pressures of equipment using stand-alone recording equipment, separate from the control system. Additional monitoring may be provided through the capabilities of the control system.
7. Deferred functional tests - functional tests that are performed after the date of substantial completion, due to partial occupancy, equipment and seasonal testing requirements, design, or other site conditions that do not allow meaningful testing of a system or piece of equipment during the normal commissioning sequence.
8. Owner's project requirements - a dynamic document prepared by the Owner that provides the explanation of the ideas, concepts and criteria that are considered to be critical to the Owner's expectations. It is initially the outcome of the programming and conceptual design phases.
9. Factory testing - testing of equipment at the factory (or on-site) by factory personnel with an Owner's representative present.
10. Functional tests - tests of the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods. Functional testing is the dynamic testing of systems (rather than just components) under full operation (e.g., the chilled water pump is tested interactively with the chiller functions to determine if the pump ramps up and down to maintain the differential pressure setpoint). Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied modes, varying outside air temperatures, fire alarm modes, and power failure. The systems are run through the control system's sequences of operation and components are verified to respond properly. The Commissioning Authority develops the functional test procedures in a sequential written form, coordinates, oversees and documents the actual testing, which is performed by the Contractor. Functional tests are performed after prefunctional checklists and start-up are complete.
11. Indirect indicators - indicators of a response or condition, such as a reading from a control system screen reporting a damper to be 100% closed.
12. Manual tests - using hand-held instruments, immediate control system read-outs or direct observation to verify performance (as opposed to analyzing monitored data taken over time to make the "observation").
13. Monitoring - the recording of parameters (flow, current, status, or pressure) of equipment operation using data loggers or the trending capabilities of control systems.
14. Over- written value – manually overriding a sensor value in the control system to determine the response of a system (e.g., changing the outside air temperature value from 50ºF to 75ºF to verify economizer operation). Also see "Simulated Signal."
15. Owner-contracted tests - tests paid for by the Owner which the Commissioning Authority does not oversee. These tests are not repeated during functional testing if properly documented.
16. Owner's Project Requirements (OPR) - A document that details the functional requirements of a project and the expectations of how it will be used and operated. These include Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, commissioning, training, documentation, and supporting information.
17. Phased commissioning - commissioning that is completed in phases (by floors, for example) due to the size of the structure or other scheduling issues, in order minimize the total construction time.
18. Prefunctional checklists - lists of items to inspect and elementary component tests to conduct to verify proper installation of equipment, provided by the Contractor to the Commissioning Authority. Prefunctional checklists are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., belt tension, oil levels, affixed labels, gauges in place, sensors calibrated). However, some prefunctional checklist items may entail simple testing of the function of a component, a piece of equipment or system (such as measuring the voltage imbalance on a 3-phase pump motor). The word prefunctional refers to testing to be accomplished prior to the formal functional testing of the installed equipment.

Prefunctional checklists augment and are often combined with the manufacturer's start-up checklist. For most equipment, the Contractor will execute the checklists.

19. Sampling - functional testing of only a fraction of the total number of identical or near identical pieces of equipment.
20. Simulated condition – a condition that is artificially created for the purpose of testing the response of a system (e.g., applying a hair dryer to a space temperature sensor to determine the response of a variable volume terminal unit).
21. Simulated signal - disconnecting a sensor and using a signal generator to send an amperage, resistance, or pressure to the transducer and control system to simulate a sensor value.
22. Start-up - the initial starting or activating of dynamic equipment, including executing prefunctional checklists.
23. Test, adjust, and balance - the process of measuring the actual flows of the air and hydronic systems, adjusting these flows to the values required by the construction documents, and documenting the results.
24. Trending - monitoring of equipment performance over a period of time, using data logging equipment or the building control system.

1.5 COORDINATION

A. The Commissioning Authority shall direct and coordinate the activities of the commissioning team.

B. The commissioning team shall consist of the Commissioning Authority, the Owner, the design team, the Contractor, and associated subcontractors.

C. Scheduling: the Commissioning Authority shall schedule the commissioning activities of the Project and shall coordinate this schedule with the Contractor. Commissioning activities shall be incorporated into the Contractor's construction schedule.

1.6 COMMISSIONING PROCESS

A. The primary role of the Commissioning Authority shall be to develop and coordinate the execution of a commissioning plan; observe and document the installation, check-out, start-up, and testing of equipment and systems to establish that they are functioning in accordance with the requirements of the construction documents; and to assist in developing correct and complete documentation of the construction effort. The Commissioning Authority shall not be responsible for design concept, design criteria, compliance with codes, design, construction scheduling, cost estimating, construction management, or construction supervision. The Commissioning Authority may assist the design team with problem-solving, or the Contractor with the correction of non-conformance items or deficiencies. The Commissioning Authority is not responsible for providing tools required to start, check-out and perform functional tests of equipment and systems, except for specified testing with supplemental portable data-loggers, which shall be supplied and installed by the Commissioning Authority.

B. Construction Phase: The Commissioning Authority shall perform the following tasks as part of the Construction Phase:

1. Participate in a Systems Commissioning Kick-Off Meeting on the project site to outline the systems commissioning process and the roles and responsibilities of each member of the commissioning team. This kick-off meeting generally takes place once rough-in of the MEP systems begins and all appropriate subcontractors are on board, including the Controls Contractor.

2. Review submittals concurrent with the design team submittal review for systems to be commissioned.

3. Based on the construction documents, the Consultant will prepare checklist forms for the building envelope components that need to be completed by the installing contractor and submitted to the Consultant for review.

4. Perform installation verification periodically during construction giving ample notice to the design and construction teams. Visits will be coordinated around construction milestones (rough-in, mock-ups, equipment start-up, etc.) and Owner, Architect, Contractor (OAC) meetings whenever possible.

5. Attend periodic OAC meetings for updates on construction progress and coordination of commissioning-related activities. Attendance at these meetings shall be coordinated around other on-site commissioning tasks when possible. The Consultant may substitute these meetings for subcontractor coordination meetings hosted by the General Contractor if beneficial and acceptable by the Owner.

6. Issue Site Visit Reports and Observation Logs upon completion of each site visit.

7. Review the Contractor's proposed start-up forms and provide recommendations for additional verifications that should be incorporated into the checklists for each applicable system or component. The Consultant will provide prefunctional checklists (systems) to the Contractor for execution in the field.

8. Witness part of the HVAC piping test and flushing procedure, sufficient to be confident that proper procedures were followed.

9. Witness part of any ductwork testing and cleaning procedures, sufficient to be confident that proper procedures were followed.

10. Maintain and update the Commissioning Observation Log through coordination of deficiency resolution with the contractors. Verify that deficiencies have been resolved while on site.

11. Review completed factory or contractor provided pre-functional checklists and start-up test forms.

12. With the necessary assistance from the installing contractors and equipment manufacturer's, prepare functional performance test procedures for the MEP systems to be commissioned. Submit draft test procedures to the Client, design team, and construction team for review and coordination at least one (1) month prior to the functional testing period.

13. Review the Test and Balance (TAB) Plan for project-specificity and standard practices. Provide review comments to the Contractor for incorporation into the revised TAB Plan.

C. Acceptance Phase: The CxA shall document the performance of the equipment and systems installed during the Construction Phase to determine if the systems meet the requirements of the construction documents. Notify the Owner and Architect of deficiencies in results or procedures. Commissioning objectives include:

1. Review the Test, Adjust and Balance (TAB) Report for completeness and provide comments as necessary.

2. Perform TAB verification to ensure the TAB Report is accurate and meets the OPR and design requirements. Verification will take place by spot testing, for at least 10% of TAB measurements, during the TAB effort.

3. Coordinate, observe, and document functional performance testing of the commissioned MEP systems as performed by the installing contractors. Once the building automation system has been pre-commissioned by the Contractor, the TAB work will be performed by the contractor; then the functional testing will be executed. Sampling will be utilized at 25% for the following components: air terminal units. All major equipment (Chillers, AHU's, etc.) shall be tested at 100% sampling rate.

4. Coordinate retesting to demonstrate satisfactory performance subject to the following limitations: Up to 10% of the commissioned MEP equipment. Additional retesting will be considered outside of the normal scope of services.

5. Review O&M and as-built documentation for completeness and accuracy.

6. Prepare a summary commissioning report with all results and documentation from the Commissioning process, which shall include but not be limited to, site visit reports, completed functional performance test procedures, and commissioning observation logs.

1.7 OWNER'S RESPONSIBILITIES

A. Develop the OPR document with assistance as necessary from the design team.

B. Assign operations and maintenance (O&M) personnel to participate in the commissioning team activities from construction through warranty phases.

C. Review selected building envelope and systems submittals where deemed appropriate by the Owner.

D. Review O&M documentation as prepared by the Contractor.

E. Participate in O&M training and document acceptance of this training as delivered by the Contractor.

1.8 CONTRACTOR'S RESPONSIBILITIES

A. The Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Data logging equipment, monitoring devices, specialized equipment, and software not specified in other Divisions to be provided by the Contractor, and provided by the Commissioning Authority to monitor, confirm, or verify the Contractor's testing procedures shall remain the property of the Commissioning Authority.

B. Test equipment, as supplied by the Contractor, shall be of the quality and accuracy required to test and/or measure system performance with the tolerances specified and shall have been calibrated within the last 12 months, or as specified herein. Equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates available on request.

1. Temperature sensors and digital thermometers shall have a certified calibration within the past 12 months and a resolution of ±0.1ºF. Accuracy of temperature test equipment shall be at least twice that of the instrumentation being tested.

2. Humidity sensors shall have a certified calibration within the past 6 months and a resolution of ±1%. Accuracy of humidity test equipment shall be at least twice that of the instrumentation being tested.

3. Pressure sensors shall have a certified calibration within the 12 months and a resolution of 0.05% of sensor range. Accuracy of pressure test equipment shall be at least twice that of the instrumentation being tested.

4. Accuracy of other sensors shall be at least twice that of the instrumentation being tested.

PART 3 - EXECUTION

3.1 REPORTING

A. Provide regular reports to the Owner and members of the commissioning team as construction and commissioning progresses, keeping them apprised of commissioning progress and scheduling changes.

B. Provide periodic commissioning reports to the commissioning team monthly until the first system test, and monthly thereafter until the completion of the Project. These reports shall include as a minimum the following:

1. Minutes of the previous commissioning meeting.

2. Copies of requests for submittals by the Commissioning Authority.

3. List of upcoming commissioning activities, as noted on project schedule.

4. Copies of functional test requirements scheduled for the following 4 weeks.

5. A list of outstanding discrepancies and the party responsible for corrective action.

C. Provide a final commissioning report to the Owner. The final commissioning report shall contain at a minimum:

1. Copies of periodic commissioning reports.

2. Copies of prefunctional test reports.

3. Copy of the final TAB Report.

4. Copies of functional test reports.

3.2 SYSTEMS TO BE COMMISSIONED

A. Mechanical systems and electrical systems shall be commissioned.

3.3 START-UP, PREFUNCTIONAL CHECKLISTS, AND INITIAL CHECK-OUT

A. Contractor shall be responsible for the initial check-out and prefunctional testing of installed equipment and systems. The Commissioning Authority shall monitor the activities of the parties responsible for executing the required start-up, and prefunctional testing, as identified in the commissioning plan. The Commissioning Authority shall review the Contractor-furnished documentation of the start-up, initial check-out, and prefunctional test procedures for equipment and systems to ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed.

B. Observe the first prefunctional test procedures for each type and size equipment to ensure that the approved procedures are being followed.

1. For lower-level components of equipment, (e.g., terminal units, sensors, controllers), observe a sampling of the prefunctional and start-up procedures. In no case, shall the number of units witnessed be less than 20% of the total number of identical or very similar units.

3.4 FUNCTIONAL TESTING

A. Functional testing of equipment or systems shall be conducted only after prefunctional testing and start-up has been satisfactorily completed. Schedule functional tests with the Contractor. Direct, witness, and document the functional testing of equipment and systems to be commissioned. The Contractor shall be responsible for the execution of the functional tests.

B. The functional testing shall demonstrate that each item of equipment and each system is operating according to the requirements of the construction documents. Each item of equipment and system undergoing functional testing shall be operated through all modes of operation where there is a required system response. Verify each action required in the sequences of operation has been accomplished according to the requirements.

C. Functional testing shall proceed from components to subsystems to systems. When the proper performance of interacting individual systems has been achieved, the interface or coordinated responses between systems shall be tested.

D. The proper and accurate operation of the control system shall be proven by functional testing and approved by the Commissioning Authority before it may be used for testing, adjusting and balancing activities or to verify performance of other components or systems. If authorized by the Commissioning Authority, portions of the control system may be tested and approved for these uses before the functional testing of the entire system is completed.

E. Air and water balancing shall be completed and corrected as necessary before functional testing of air-related or water-related equipment or systems.

F. Test Methods:

1. Functional testing and verification shall be achieved by manual testing (direct manipulation of the equipment and observation of its response and performance) or by monitoring the performance using the control system's trend log capabilities or by stand-alone data loggers and analyzing the results. Functional test procedures shall specify which methods shall be used for each test. Determine which method is most appropriate for tests that do not have a method specified. The Commissioning Authority may substitute specified methods or require an additional method to be executed, other than that specified, if required to demonstrate the proper operation of the equipment or system being tested. Develop functional testing plans that define the allowable sampling procedures and that specify the procedures to be followed in the case of observed discrepancies or failures in the sample chosen for functional testing.

2. If any equipment fails to perform to the requirements of the construction documents (mechanically or substantively) due to manufacturing defects or application error not allowing it to meet its performance specification, identical units may be considered unacceptable by the Commissioning Authority. In such case, the Contractor shall provide the Commissioning Authority with the following:

    a. After notification from the Commissioning Authority, the Contractor or manufacturer's representative shall examine other identical units making a record of the findings. The findings shall be provided to the Commissioning Authority

    b. The Contractor shall provide a signed and dated, written explanation of the problem, cause of failures, and proposed solution, including full equipment submittals for corrective or replacement equipment, if appropriate. The proposed solutions shall meet the specified requirements of the original installation.

    c. The Commissioning Authority shall evaluate the proposed solution and submit his recommendation of approval or disapproval to the Owner and Architect.

    d. When approved, the proposed solution shall be installed by the Contractor and the Commissioning Authority shall schedule and conduct functional testing of the proposed solution. Upon completion of the functional testing of the proposed solution, the Commissioning Authority shall recommend the acceptance or disapproval of the proposed solution to the Owner. The Commissioning Authority shall provide a copy of his recommendations to the Architect.

    e. Upon acceptance of the proposed solution by the Owner, the Contractor shall replace or repair identical items and extend the warranty accordingly, if the original equipment warranty had begun.

3. Ensure that each functional test is performed under conditions that simulate actual operating conditions as closely as is practically possible.

4. Simulation of operating conditions (not by an overwritten value) shall be allowed, at the Commissioning Authority's discretion, though timing the testing to experience actual conditions is encouraged wherever practical. Simulation of conditions shall be accomplished by subjecting the equipment to actual operating conditions by artificial means whenever possible.

5. Where actually achieving a simulated operating condition is impractical, as determined by the Commissioning Authority or identified in the functional test procedure, a signal generator which creates a simulated signal to test and calibrate transducers and BAS constants shall be used instead of using the sensor to act as the signal generator via simulated conditions or overwritten values. Signal generators or simulators shall be provided by the Contractor.

6. Overwriting sensor values to simulate a condition, such as overwriting the outside air temperature reading in a control system to be different than it really is, shall be allowed when approved by the Commissioning Authority, but shall be used with caution and avoided when possible. Simulation of the operating condition is preferable.

7. Altering setpoints: rather than overwriting sensor values, and when simulating conditions is difficult, altering setpoints shall be used to test a sequence

8. Indirect indicators: relying on indirect indicators for responses or performance shall be allowed only after the Commissioning Authority has visually and directly verified that the indirect readings represent actual conditions and responses over the range of the tested parameters.

G. During the functional testing process, recommend solutions to deficiencies found.

3.5 RETESTING OF EQUIPMENT AND/OR SYSTEMS

A. Prior to retesting of any functional performance test found to be deficient, submit the data indicating that the deficient items have been completed and/or corrected to the Commissioning Authority. After review of the submitted data, if the corrective measures are acceptable, the Commissioning Authority shall schedule and conduct a recheck. If during the retesting it becomes apparent that the deficient items have not been completed and/or corrected as indicated in the data provided by the Contractor, the retesting shall be stopped. If after one retest of each type of equipment it becomes apparent that the deficient items have not been completed and/or corrected as indicated in the data provided by the Contractor, the retesting shall be stopped. Costs for the commissioning team to further supervise the retesting of a functional performance test shall be the responsibility of the Contractor.

3.6 DOCUMENTATION, NONCONFORMANCE, AND APPROVAL OF TESTS

A. Witness and document the results of functional tests using the specific procedural forms developed for that purpose. Deficiencies or nonconformance issues shall be noted and reported with the test results. Include the completed test forms in the final commissioning report.

B. As functional testing progresses and a deficiency is identified, discuss the issue and attempt to resolve the discrepancy with the Contractor.

1. When there is no dispute about the deficiency and the Contractor accepts responsibility for correcting it, document the deficiency and the Contractor’s response and intentions and the testing shall proceed, if possible. Corrections of minor deficiencies identified may be made by the Contractor during the functional testing, at the discretion of the Commissioning Authority. In such cases the deficiency and resolution shall be documented on the functional test form. Every effort shall be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the commissioning effort. When the Commissioning Authority determines that the required corrective actions will delay the testing process, document the observed deficiency and the proposed corrective action on the functional test form.

2. When the identified deficiency is corrected, the Contractor shall sign the statement of correction at the bottom of the noncompliance form, certifying that the equipment is ready to be retested, and return the form to the Commissioning Authority. The Commissioning Authority shall schedule the retest of the equipment or system involved.

3. If there is a dispute about an identified deficiency, document the deficiency and the Contractor's response, and submit the noncompliance report to the Owner and Architect, with a copy furnished to the Contractor. Every attempt shall be made to resolve the dispute at the lowest management level possible. Other parties shall be brought into the discussions by the Commissioning Authority, as needed. Document the resolution process. When the dispute resolution has been decided, the appropriate party shall correct the deficiency, sign the statement of correction on the noncompliance form and return the form to the Commissioning Authority. The Commissioning Authority shall schedule the retest of the equipment or system involved. Final interpretive authority for any issue in dispute shall be the Architect. Final acceptance authority shall be the Owner.

4. Retain the original nonconformance forms until the end of the Project. The completed forms shall be delivered to the Owner as a part of the final commissioning report.

C. Approval: note each satisfactorily demonstrated function on the functional test form. Formal approval of the functional tests shall be made after review of the test reports by the Commissioning Authority and Owner. Recommend acceptance of each test to the Owner using a standard form. The Owner shall give final approval on each test using the same form, providing a signed copy to the Commissioning Authority and the Contractor.

3.7 DEFERRED TESTING

A. If any required prefunctional or functional test cannot be completed as scheduled, execution of checklists and functional testing may be delayed upon approval of the Architect and the Commissioning Authority. These deferred tests shall be conducted in the same manner as the seasonal tests as soon as possible

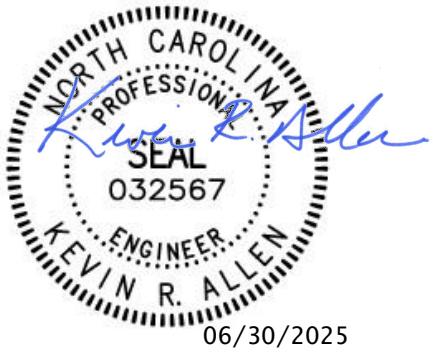
B. Schedule and coordinate any required seasonal testing, tests delayed until weather or other conditions are suitable for the demonstration of the equipment or system's performance. Seasonal testing shall be executed, documented, and deficiencies corrected as specified herein for functional testing. Any adjustments or corrections to the operations and maintenance manuals and record documents required by the results of the testing shall be made before the seasonal testing process is considered complete. Schedule deferred testing with the Contractor, the Architect, and the Owner.

END OF SECTION

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SECTION 019913 - GENERAL REQUIREMENTS FOR DIVISIONS 21-28 WORK

The "Engineer of Record" for the work defined by Division 01 Sections 019913, 019113, 019916, 019919 and 019926 is Salas O'Brien North Carolina, Inc., 702 Oberlin Road, Suite 300, Raleigh, NC 27605 (919) 832-8118. The term "engineer," "architect-engineer," "engineer-architect," "A-E," "E-A," etc., when used in these Sections shall reference Salas O'Brien.



06/30/2025

The "Engineer of Record" for the work defined by Divisions 21-28 is Salas O'Brien North Carolina, Inc., 702 Oberlin Road, Suite 300, Raleigh, NC 27605 (919) 832-8118. The term "engineer," "architect-engineer," "engineer-architect," "A-E," "E-A," etc., when used in Divisions 21-28 Drawings and Specifications shall reference Salas O'Brien.

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification sections, apply to this section.

The requirements specified herein shall govern all Sections in Divisions 21-28, whether stated therein or not.

Where items specified in the other sections of this Division conflict with requirements of this Section, the former shall govern.

REVIEW OF CONTRACT DOCUMENTS

The Contract Documents may represent imperfect data and may contain errors, omissions, conflicts, inconsistencies, code violations and improper use of materials. Such deficiencies will be corrected by the A-E when identified. The Contractor shall carefully study and compare the individual Contract Documents with each other and report at once in writing to the A-E any deficiencies the Contractor may discover. The Contractor shall require each subcontractor to likewise study the documents and report at once any deficiencies discovered. The Contractor shall resolve all reported deficiencies with the A-E prior to starting any work. **Any work performed prior to receipt of instructions from the A-E will be done at the Contractor's risk.** If the Contractor performs any construction activity knowing it involves a recognized error, inconsistency, or omission in the Contract Documents without such notice to the A-E, the Contractor shall assume appropriate responsibility for such performance and shall bear an appropriate amount of the attributable costs for correction.

The Contractor shall be responsible for maintaining habitable structures under this Contract rainproof, and for making equipment and utility installations properly perform the intended function. If he is prevented from so doing by any limitations of the drawings or specifications, the Contractor shall immediately notify the A-E in writing of such limitations before proceeding with construction in the area where the problem or limitation exists.

DEFINITIONS

Docusign Envelope ID: A708AC2D-32EE-419A-BBBD-70DD021DD26A

Mechanical Work: Work required by this Contract as defined by specification Division 21 (Fire Protection), Division 22 (Plumbing), and Division 23 (Heating, Ventilating, and Air-Conditioning).

Electrical Work: Work required by this Contract as defined by specification Divisions 26-28.

Labeled: Appliances, equipment, materials or products to which has been attached a label, symbol, or other identifying mark of an organization acceptable to the North Carolina Building Code Council and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials and by whose labeling the manufacturer indicates compliance with identified standards or has been tested and found suitable for a specified purpose.

Listed: Appliances, equipment, materials or products included in a list published by an organization acceptable to the North Carolina Building Code Council and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials, and whose listing states either that the equipment or material meets appropriate designated standards or has been tested and found suitable for a specified purpose.

Concealed: Work within or behind various construction elements or in crawl spaces or trenches that is not exposed to view when the project is complete.

Exposed: Not "concealed" as defined above, or anything exposed to view when the project is complete.

Wiring: Cable, raceways, fittings, mechanical supports, wire, junction boxes, device boxes, outlet boxes, switches, cutouts, and related items.

CODES, LAWS, REGULATIONS, AND STANDARDS

Work on and for the project shall conform to requirements of each applicable volume of the *North Carolina Building Code*; shall comply with the regulations of the N.C. Department of Labor, including the latest revisions and interpretations of the *Occupational Safety and Health Act of North Carolina;* and be in accordance with all other codes, laws, rules and regulations that apply to this project.

"Confined spaces" and "permit-requiring confined spaces", as defined by U.S. Occupational Safety and Health Administration (USOSHA) may exist in the work area or may be created by the construction of this Project. The Contractor shall be responsible for identification of any permit-requiring confined spaces and for establishing all required procedures for meeting the requirements of USOSHA relative to these spaces, including written confined space entry program(s).

Codes, laws, regulations, and/or industry standards referenced in the Specification or on the Drawings shall be considered to be part of the Project requirements. Applicable edition of the referenced volume is the edition that is/was in effect at the time the construction permit was issued or at the time of approval of the Contract Documents by the Authority Having Jurisdiction.

INTENT AND WORKMANSHIP

The words "furnish," "furnish and install," "install," and "provide" or words with similar meaning shall be interpreted, unless otherwise specifically stated, to mean "furnish and install complete in-place and ready for service."

The work of all trades under this Contract shall be coordinated in such a manner as to obtain the best workmanship possible.

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Miscellaneous items and accessories that are not specifically shown on the drawings or specified herein, but which are essential to produce a complete and properly operating installation, or usable structure or plant, providing the indicated function, shall be furnished and installed without change in the Contract price. Such miscellaneous items and accessories shall be of the same quality standards, including material, style, finish, strength, class, weight and other applicable characteristics, as specific for the major component of which the miscellaneous item or accessory is an essential part. The above requirement, however, is not intended to include major components not covered by or inferable from the drawings and specifications.

WELDER QUALIFICATION

Where welding is required on vessels or piping with an ASME P- or S- stamp, qualify welders for welding procedures complying with ASME *Boiler and Pressure Vessel Code*, Section IX. Submit *Welder's Performance Qualification Record* required by the ASME *Boiler and Pressure Vessel Code*.

For piping and structural supports welding, qualify welders in accordance with AWS QC7 *Standard for AWS Certified Welders* for welding procedures complying with ASME B31.1 or ASME B31.9, as applicable. Submit *Welder's Performance Qualification Record* required by ASME B31.1 or B31.9 and a copy of the most recent *Maintenance of Welder Certification* form submitted to AWS.

In addition, submit each welder's assigned number, letter, or symbol used to identify the work of the welder. This symbol shall be stamped in or adjacent to each completed weld.

QUALITY ASSURANCE

The Contract Drawings indicate the extent and general arrangement of the Work. The Contractor shall coordinate the Work under his Contract so as to avoid conflicts between his work and the work of other trades. He shall carefully examine the Drawings and shall be responsible for the proper fitting of materials and equipment into the space provided. If any departures from the Contract Drawings are deemed necessary by the Contractor, detail drawings of such departures and the reasons therefore shall be submitted as soon as practicable to the A-E for his review. No such departures shall be made without this review and written clarification or change order.

If manufacturer recommended details or installation instructions differ from the contract drawings or specifications, then the contractor shall notify the A-E immediately of any discrepancies.

The Drawings and Specifications shall be considered supplementary, one to the other, so that materials and/or labor indicated, called for, or implied by one and not the other shall be provided as though specifically called for in both.

Firestop Materials Codes and Standards: Comply with ASTM Standard E814 and applicable categories of UL's current *Fire Resistance Directory*, Vol. I and II, for compliance with ANSI/UL Standard 1479.

Access Doors Fire-Resistance Ratings: Where fire-resistance rating is indicated for construction penetrated by access units, provide Listed and Labeled units.

OBSERVATION

All work shall be done by skilled technicians, continuously supervised by the Contractor and subject to observation and final acceptance by the A-E. Such final acceptance shall in no way relieve the Contractor from responsibility for defects in either workmanship or material that may subsequently develop.

SUBMITTALS

Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Material and equipment schedules, catalog cuts, manufacturers' data and shop drawings, and field working drawings as required by individual Sections shall be provided.

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Shop drawings, technical data and other such submittals required by individual Sections of the Divisions listed above shall be provided.

Equipment drawings, manufacturer's installation instructions as shipped with the equipment, field working and location drawings, wiring diagrams, and coordination drawings shall be provided by the Contractor for items of equipment, sleeves, foundations, curbs, wiring, ductwork, piping, etc., as necessary for information and coordination of all trades. These drawings shall be provided sufficiently in advance of installation to avoid delays and removal and reworking of installed work, and so as to provide information to other trades when and as required. No work shall be done until these drawings have been coordinated by the Contractor.

Submittals shall be checked before submission by technically qualified employees of Contractor for accuracy, completeness and compliance with Contract requirement. **All submittals shall be accompanied by the "Submittal Cover Form" provided at the end of this Section, signed by Contractor**.

Contractor shall submit complete lists or schedules of all proposed sub-contractors and material suppliers, and of all proposed construction materials and equipment. Materials and equipment lists shall be complete with trade names and/or catalog numbers of each item. Processing of the second and subsequent Certificate for Payment will be withheld until substantial portions of these lists have been submitted.

Products furnished shall be essentially the standard product of the manufacturer. Where two or more units of the same class of equipment are required, these units shall be products of a single manufacturer.

Products proposed by the Contractor shall be new except where specifically noted otherwise. Contractor(s) shall provide products only from manufacturers who have published data showing compliance with specified requirements or who certify in writing to such compliance (including laboratory and/or in-place testing, if applicable). All electrical products shall be both labeled and listed, as defined above. **Prior to purchase of major materials, equipment or systems, submit manufacturer's data to the A-E for review as hereinafter specified.**

Products of the specified type and for the specified application offered by the Contractor(s) for use on this Project shall comply with the following requirements:

Product shall have had satisfactory performance in applications of similar character to that specified for a period of at least three (3) years.

Product shall be from an established national or regional manufacturer. The A-E’s experience with the manufacturer on prior projects relative to product performance, technical support, etc. may be taken into account to establish suitability of the offered product for this Project.

Product shall be provided through an authorized representative of the manufacturer. The representative shall be capable of providing technical support relative to the installation, operation, and maintenance of the product. The A-E’s experience with the representative on prior projects relative to product performance, technical support, etc. may be taken into account to establish suitability of the offered product for this Project.

Repair parts and service for the product shall be available within twenty-four (24) hours of notice.

The manufacturer and his authorized representative shall furnish satisfactory evidence in support of these conditions when requested. The A-E’s decision relative to the suitability and acceptability of any product is final and acceptance of this limitation is implicitly acknowledged by the contractor and the manufacturer and/or his representative offering the product for use on this Project.

Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the specifications the submittal shall clearly indicate such deviations by being marked "**NON-COMPLYING FEATURE**." This indication shall be applied to the submittals at the appropriate location in a color contrasting with the remainder of the submittal. Additional information that might assist the Engineer in product evaluation may be included with the submittal. This information should indicate how a specific non-complying feature is believed by the Contractor to meet the intent of the specification.

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It is the Contractor's responsibility to demonstrate compliance with the specifications and to clearly indicate any features that do not meet the specifications. It is not the Engineer's responsibility to identify non-compliance. Substantial non-compliance, as determined by the Engineer, is grounds for rejection of the submittal. Discovery of non-complying features that have not been properly identified as such on submittals may require, at any stage of construction, the removal and replacement of the non-complying item(s).

The A-E will review shop drawings, manufacturer's data, and samples with reasonable promptness. This review is only for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. Corrections or comments made on the shop drawings during this review do not relieve contractor from compliance with the requirements of the plans and specifications. Approval of a specific item shall not include approval of an assembly of which the item is a component. Contractor is responsible for dimensions to be confirmed and correlated at the jobsite; information that pertains solely to the fabrication processes or to the means, methods, techniques, sequences and procedures of construction; coordination of his or her Work with that of all other trades; and for performing all work in a safe and satisfactory manner. The Contractor is responsible for any delay caused by his failure to observe submittals requirements and the time for completion of his Contract will not be extended because of such delays.

The A-E's submittals review stamp categories shall be interpreted as follows:

Reviewed: Fabrication and installation or erection may be undertaken.

Exceptions indicated, revise and proceed: Fabrication and installation of erection may be undertaken. However, Contractor shall comply with all notes or corrections indicated.

Exceptions indicated, revise and re-submit: Neither fabrication, installation, nor erection shall be undertaken. Re-submit corrected copies for review. Corrections shall be limited to items marked, except that changes required in order to coordinate the corrections indicated shall be made. All changes, other than those indicated, shall be called specifically to the A-E's attention.

Rejected, re-submit: Neither fabrication, installation, nor erection shall be undertaken. Revise entire submission to comply with information given in the Contract Documents and re-submit.

Submittals returned to the Contractor with the A-E's "reviewed" or "exceptions indicated, revise and proceed" stamp need not be resubmitted, except that corrected copies of "exceptions indicated, revise and proceed" submittals shall be furnished for record when requested.

Submittals returned to the Contractor with the A-E's "revise and re-submit" or "rejected, re-submit" stamp shall be corrected to comply with Contract requirements and re-submitted to the A-E for review. The Contractor shall direct specific attention, in writing or on re-submitted shop drawings, product data or samples, to revisions other than those requested by the A-E on previous submittals.

Shop drawings of work that involves more than one subcontractor shall be coordinated by the Contractor and submitted to A-E under one cover. No items shall be fabricated, nor any portion thereof shipped to site, prior to receipt by the Contractor of all applicable submittals, including manufacturer's data, samples and shop drawings bearing the A-E's "reviewed" or "exceptions indicated" stamp only.

Manufacturer's data submitted as required by the technical specifications sections or requested by A-E shall consist of four (4) copies of certificates, schedules, catalog cuts, manufacturer's specifications and installation instructions for each type of product or material. Include maintenance recommendations, fire ratings and other reports when applicable to show compliance with the Specifications. When catalog cuts are submitted, the specific item to be considered shall be identified. Items that are not so identified will be returned to the Contractor without action.

Firestop Systems: Submit data on products. Provide manufacturer's certification of UL classification(s) required, including copies of UL systems listings and schedule defining each UL system proposed and the applicable type of penetration.

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Access Units: Submit manufacturer's technical data and installation instructions for each type of access door assembly, including setting drawings, templates, instructions and directions for installation of anchorage devices.

Contractor shall submit for review any samples required by the technical specification sections or that may be requested by the A-E.

With each electrical testing and compliance submittal, Contractor shall submit evidence of compliance that each manufactured item or component of electrically-operated equipment and that each fabricated assembly of electrically operated equipment furnished complies with the testing requirements.

FIRE RATINGS

Fire rating of walls and floors, as indicated on the Drawings, are for reference only. Refer to Architectural Drawings for exact construction and fire ratings.

Where fire resistive insulation or other coverings have been applied to a structural element to obtain a fire rating and this insulation or covering is removed or otherwise disturbed, the Contractor shall be responsible for restoring the material to a condition that matches the original fire protective ability.

USE OF BRAND NAMES

Brand names, where scheduled as “basis of design,” are to be considered for information purposes and are not intended to be a product specification.

Where the Contractor proposes to use an item of equipment other than that indicated as basis of design that may require redesign of the structure, partitions, foundations, piping, wiring, or any other part of the mechanical, electrical, or architectural layout, all such redesign and all new drawings and detailing required shall be prepared by the Contractor at his own expense and submitted for review by the A-E.

Where such deviation requires a different quantity and arrangement of ductwork, piping, wiring, raceway, or equipment from that specified or indicated on the Drawings, the Contractor shall furnish and install any such ductwork, piping, structural supports, insulation, controllers, motors, starters, electrical wiring and raceway, and any other additional equipment required by the system, at no additional cost.

Brand names, where used as a product specification, are intended to denote the standard of quality required for the particular material or product.

Where the term “equal” or “equivalent” is present, such specification does not restrict the Contractor to a specific brand and equivalent products by other manufacturers may be acceptable. The term "equal" or "equivalent" shall be interpreted to mean a material or product that is similar and equal in type, quality, size, capacity, composition, finish, color, and other performance characteristics to the material or product specified by brand name, and that, **in the opinion of the A-E**, is suitable for the same use and capable of performing the same function as the material or product specified. **Proposed equivalent items must be reviewed by the A-E before they are purchased or incorporated into the work**.

EQUIPMENT SUBSTITUTIONS AND CHANGES/EXTRA COSTS FOR CHANGES IN BUILDING SERVICES

Where the Contractor proposes to use an item of equipment other than that specified or detailed on the Drawings, requiring any redesign of the structure, partitions, foundations, piping, wiring, or any other part of the mechanical, electrical, or architectural layout, all such redesign and all new drawings and detailing required shall be prepared by the Contractor at his own expense and submitted for review by the A-E.

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Where such approved deviation requires a different quantity and arrangement of ductwork, piping, wiring, raceway, or equipment from that specified or indicated on the Drawings, the Contractor shall furnish and install any such ductwork, piping, structural supports, insulation, controllers, motors, starters, electrical wiring and raceway, and any other additional equipment required by the system, at no additional cost.

It is the responsibility of the Contractor to notify the A-E in all cases where the requirements of proposed equipment differ from the requirements specified, shown, or implied on the Drawings or within the Specifications. **Failure of the Contractor to notify the A-E shall not relieve the Contractor of the responsibility of providing compatible equipment at no additional cost as described above**.

OPERATION AND MAINTENANCE DATA

For each Division of the Work, provide four (4) copies of Operating Manuals, Maintenance Manuals, and Test Reports, bound in suitable covers, to the A-E at least two (2) weeks **prior** to the final inspection of the project.

Each manual shall include a cover sheet listing the following:

Project name and location.

Division of Work covered by the manual.
Contractor data, including name, address, phone and fax numbers, and service contact information (24-hour number, email address, etc.)

Date of project completion.

Each manual shall include a table of contents.

Operating manual: Provide all relevant information needed for day-to-day operation and management of the building systems. Include the following for each system:

System Description: Identify the areas of the building the system serves, the locations of performance checkpoints, the expected performance readings at the design load conditions and, where applicable, at part-load conditions. The system's operation during the day, night, and weekend, as well as seasonal start-up and shutdown, safety devices and their function, control devices and their function, pollution control devices, etc., also shall be described. The function of the controls for individual systems shall be described alongside the description of the system function.

Operating Routines and Procedures: Identify activities associated with the normal operation of systems and equipment. Operating checklists and operating logs shall be provided for each system and all performance standards shall be identified.

Seasonal Start-Up and Shutdown: List seasonal start-up and shutdown procedures, including any "mothballing" procedures required.

Special Procedures: Special procedures related to environmental control, health and safety, productive work environment, etc., shall be codified.

Troubleshooting Procedures: This section shall include questionnaires and diagnostics to allow users to isolate probable causes of operating problems in an efficient manner.

Maintenance manual: The maintenance manual shall be divided into two parts:

Part I shall contain information related to the equipment data sheets, nameplate data, operating data, etc. Include the original purchase order number; date of purchase; name, address, and phone number of vendor; and warranty information.

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Part II shall support a maintenance program. The manual shall contain information prepared by the equipment manufacturers, but shall be supplemented by information provided by the Contractor. Each item of equipment shall be identified and an individual "Equipment Maintenance Sheet" shall be prepared for each, with the following information:

Description each system and system component, consisting of easily read schematic drawings showing all components, identified to match Part I data, that requires maintenance.

Recommended preventative and predictive maintenance procedures and their recommended frequency of application for each system component.

Recommended list of spare parts with part numbers and place(s) they can be obtained.

Copy of manufacturer's Installation instructions for each component.

Any other information requested by the A/E to support the operation and maintenance of the equipment.

Test reports: Provide copies of the test protocols used in the construction and commissioning of the systems. Arrange data so as to allow the results of ensuing tests to be easily added.

PART 2 - PRODUCTS

MACHINERY DRIVES

V-Belt Drives: Provide ANSI/Rubber Manufacturers Association (RMA) standard or raw edge cogged V-belts with properly-selected motor pulley and driven sheave. Belts shall be constructed of reinforced cord and rubber.

The drive shall be rated for the motor horsepower indicated on the Drawings, plus the recommended ANSI/RMA service factor (but, not less than 20%), in addition to the ANSI/RMA allowances for pitch diameter, center distance, and arc of contact.

Drives 1 horsepower and smaller may be provided with single standard V-belt. Drives 1-1/2 horsepower and larger shall be provided with raw edge cogged V-belts, the number of belts necessary to transmit the required power with 95% minimum efficiency, but in no case less than 2.

Exception: **Belt drives for fans utilized as part of smoke control and/or smoke venting systems shall be rated for the motor horsepower indicated on the Drawings, plus 50% additional service factor, in addition to the ANSI/RMA allowances for pitch diameter, center distance, and arc of contact, and shall have at least 2 belts.**

Multiple belts shall be matched to ANSI/RMA specified limits by measurement on a belt measuring fixture. Seal matched sets together to prevent mixing or partial loss of sets. Replacement, when necessary, shall be an entire set of new matched belts.

Sheaves and pulleys shall be fixed pitch type, statically and dynamically balanced, and constructed as follows:

Construction of pressed steel or close grained cast iron.

Bore shall be fixed or bushing type for securing to shaft with keys.

Groove spacing for driving and driven pulleys shall be the same.

Maximum belt speed shall not exceed 5000 feet per minute.

Minimum motor sheave diameter shall comply with ANSI/RMA recommendations as follows:

Shaft Couplings: Shaft couplings for direct drive equipment driven by polyphase motors shall be flexible type capable

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of absorbing vibration, rated for the motor horsepower indicated on the Drawings plus an additional 50% service factor. Couplings shall be drop-out type to allow disassembly and removal without removing equipment shaft or motor.

Drive Guards: Drive guards shall be provided for belt drives and shaft couplings.

Belt guards shall comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

Coupling guards shall be constructed steel and comply with ANSI B15.1, Section 8, and OSHA 1910.219. Guards shall be easily removable for access and service and provided with openings for speed checks, etc. without removal.

FIRESTOPPING SYSTEMS

Firestop systems shall be used in locations including, but not limited to, the following:

Penetrations through fire resistance rated floor assemblies and roof assemblies (where required by code) including both empty openings and openings containing penetrants.

Penetrations through fire resistance rated wall assemblies including both empty openings and openings containing penetrants.

Membrane penetrations in fire resistance rated wall assemblies where items penetrate one side of the barrier.

Membrane penetrations in fire resistance rated ceiling assemblies.

Systems or devices must be listed in the UL Fire Resistance Directory and must conform to construction type, penetrant type, annular space requirements and fire rating involved in each separate instance. System must be symmetrical for wall applications.

Systems or devices must be asbestos-free and all products must be from a single manufacturer.

Products must withstand the passage of cold smoke, either as an inherent property of the system or by the use of a separate product included as part of the UL system or device, and designed to perform this function.

Cracks, Voids, or Holes Up to 4" Diameter: Putty or caulking, one-piece intumescent elastomer, non-corrosive to metal, compatible with synthetic cable jackets, Listed, and capable of expanding 10 times when exposed to flame or heat.

Openings 4" or Greater: Sealing system capable of passing 3-hour fire test in accordance with ASTM E-814, consisting of wall wrap or liner, partitions, and end caps capable of expanding when exposed to temperatures of 250 to 350 deg. F (121 to 177 deg. C), Listed.

Wall Boxes:

Metallic boxes used in fire-rated walls or floors must be listed in the UL Fire Resistance Directory under category CEYY.

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Listed single and double gang metallic device and outlet boxes with metallic or nonmetallic cover plates may be used in bearing and nonbearing wood stud and steel stud walls with ratings not exceeding 2 hours. The metallic outlet or switch boxes shall be securely fastened to the studs and the opening in the wallboard facing shall be cut so that the clearance between the box and the wallboard does not exceed 1/8 in. The surface area of individual metallic outlet or switch boxes shall not exceed 16 sq. in. The aggregate surface area of the boxes shall not exceed 100 sq. in. per 100 sq. ft. of wall surface.

Metallic boxes located on opposite sides of walls or partitions shall be separated by a minimum horizontal distance of 24 in. This minimum separation distance between metallic boxes may be reduced when “Wall Opening Protective Materials” listed in the UL Fire Resistance Directory under category CLIV are installed according to the requirements of the Classification.

Metallic boxes shall not be installed on opposite sides of walls or partitions of staggered stud construction unless “Wall Opening Protective Materials” are installed with the metallic boxes in accordance with Classification requirements for the protective materials.

WALL AND FLOOR ACCESS DOORS

Where floors, walls and ceilings must be penetrated for access to engineering work, provide types of access doors indicated, including floor doors if any. Furnish sizes indicated or, where not otherwise indicated, furnish 24" x 24" panels. Furnish manufacturer's complete units, of type recommended for application in indicated substrate construction, in each case, complete with anchorages and hardware.

Except as otherwise indicated, fabricate wall/ceiling door units of welded steel construction with welds ground smooth, 16-gage frames and 14-gage flush panel doors, 175 deg. swing with concealed spring hinges, flush screw-driver-operated cam locks, factory-applied rust-inhibitive prime-coat paint finish.

Provide rated access doors where installed in fire resistance rated floor and wall assemblies to meet fire rating.

PART 3 – EXECUTION

GENERAL

Comply with NFPA 241, *Standard for Safeguarding Construction, Alterations, and Demolition Operations*; ANSI A10 Series standards for *Safety Requirements for Construction and Demolition*; and Chapter 14 of the *North Carolina State Building Code: Fire Code*.

FIRE PROTECTION DURING CONSTRUCTION

Building contents and all elements of new and/or existing construction must be thoroughly protected from construction procedures that produce sparks, flames, or excessive heat. Such procedures include, but are not limited to, welding, soldering, flame-cutting, using grinders or metal cutting saws, and heating of work spaces. Contractor shall maintain fire watch and/or portable fire-suppression devices, as required, during these operations.

The Contractor shall develop, provide, and post a written plan in compliance with NFPA 241 and Chapter 14 of the *North Carolina State Building Code: Fire Code*.

Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures required to prevent fires and how to deal with them if they occur.

Provide and maintain portable, UL rated fire extinguishers with class and extinguishing agent as required by locations and classes of fire exposures. Comply with NFPA 10 *Standard for Portable Fire Extinguishers.* Locate fire extinguishers where convenient and effective for their intended purpose, but not less than one extinguisher on each floor or area at or near each usable stairwell.

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SECURITY AND SAFETY DURING CONSTRUCTION

Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.

Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.

MOISTURE AND MOLD CONTROL DURING CONSTRUCTION

Exposed Construction Phase: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:

Protect porous materials from water damage.
Protect stored and installed material from flowing or standing water.

Keep porous and organic materials from coming into prolonged contact with concrete.

Keep roof, wall, and/or openings covered or dammed.

Partially Enclosed Construction Phase: After installation of weather barriers, but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:

Do not load or install porous materials or components, or items with high organic content, into partially enclosed building.

Keep interior spaces reasonably clean and protected from water damage.

Periodically collect and remove waste containing cellulose or other organic matter.

Discard or replace water-damaged material.

Do not install material that is wet.

Discard, replace, or clean stored or installed material that begins to grow mold.

Perform work in a sequence that allows any wet materials adequate time to dry before enclosing the material in drywall or other interior finishes.

Controlled Construction Phase of Construction: After completing and sealing of the building enclosure, maintain as follows:

Control moisture and humidity inside building by maintaining effective dry-in conditions.

Use **temporary** HVAC units or system to control humidity.

Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.

Hygroscopic materials that may support mold growth that become wet during the course of construction and remain wet for 48 hours are considered defective and must be replaced.

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DUST AND CONTAMINATION CONTROL DURING CONSTRUCTION

Prevent dust, fumes, and odors from entering occupied areas or areas in which construction work is more advanced

Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Owner from fumes and noise. Construct dustproof partitions with two layers of 6-mil polyethylene sheet on each side. Cover floor with two layers of 6-mil polyethylene sheet, extending sheets 18 inches up the sidewalls. Overlap and tape full length of joints. Cover floor with fire-retardant-treated plywood.

Maintain negative air pressure within the work area using HEPA-equipped air-filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.

Use vacuum collection attachments on dust-producing equipment. Isolate limited work areas using portable dust-containment devices.

Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.

Coordinate general construction activities with the work of Divisions 21-28 to avoid contamination and/or degradation of building engineered systems by dust, over-spray of insulation or paint, etc. **Costs for the cleaning and/or component replacement of engineered systems required by contamination and/or degradation by general construction activities shall be assigned to the General Contractor.**

TEMPORARY HVAC SYSTEMS USE DURING CONSTRUCTION

The use of permanent HVAC systems to support construction activities is prohibited. The need for heating, cooling, dehumidification, and/or ventilation during construction shall be met via use of temporary HVAC units or systems as follows:

Heating: Provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.

Cooling: Provide modular, portable stand-alone direct expansion cooling units with condensers vented to the outdoors.

Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.

COOPERATION WITH OTHER TRADES

The Contractor shall give full cooperation to other trades and shall furnish any and all information necessary to permit the work of other trades. Information to be provided by the Contractor includes, but is not limited to templates, patterns, setting plans, and shop details as may be necessary for the proper installation of work and for the purpose of coordinating adjacent work. Information required by other trades shall be provided in a timely manner and shall be sufficient to allow the work of such other trades to proceed with the least possible interference or delay.

Where the work of the Contractor will be installed in close proximity to, or may interfere with work of other trades, the Contractor shall assist in working out space conditions to make a satisfactory adjustment. **If the Contractor installs his work before coordination with other trades, he shall make the necessary changes in his work to correct the condition without extra charge.**

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MISCELLANEOUS CONCRETE AND STEEL SUPPORTS

All concrete curbs, bases, etc., required for mechanical or electrical equipment and components shall be provided under the Division requiring them except where specifically indicated and/or specified to be provided under a different Division.

"Housekeeping pads", constructed of 3000 psi concrete doweled to floor slab, shall be provided for each floor-mounted component. Pads for air-handling units shall, unless indicated otherwise on the drawings, be 6" high, while pads for all other equipment shall be 4" high. Pads shall be finished smooth with chamfered top edges and corners. Equipment and other floor-mounted elements shall be installed and shall be anchored and grouted to housekeeping pads.

Miscellaneous steel for equipment, pipe, duct, raceway, etc. installation required by the work in any Division shall be provided and placed under that Division except where specifically indicated and/or specified to be provided under a different Division.

Anchors, inserts, supports, attachments, etc., required and but not indicated on the Drawings shall be provided under this Contract.

WIND LOADING

Delegated Design: **Responsibility for the design of manufactured equipment and/or field-fabricated components installed outdoors to withstand wind loading, including comprehensive engineering analysis by a qualified professional engineer licensed in the State of North Carolina, using performance requirements and design criteria hereinafter specified, is delegated to the Contractor.**

Performance Requirements and Design Criteria:

> Equipment and/or field-fabricated components installed outdoors as part of Divisions 21-28 Work shall be fabricated and anchored to the ground or building structure, as applicable, to withstand a wind load imposed on the largest vertical or projected surface area, at maximum wind speed by the *North Carolina State Building Code: Building Code* for the Project location, in accordance with ASCE/SEI 7.
>
> Outdoor piping and raceway shall be anchored by using a U-bolt, strap, or other hold-down device anchored at each support point. Equipment and other components shall be anchored by using structural frames, straps, or other hold-down devices anchored to foundations, structural supports, or roof curbs, as applicable.

FIRESTOPPING

Installer should be experienced in installing or applying similar systems, plus: be acceptable to or licensed by manufacturer, state or local authority where applicable; have at least five years experience; and have successfully completed at least five comparable projects using this system.

Firestop systems or devices installation must meet requirements of ASTM E-814, UL 1479 or UL 2079 tested assemblies that provide a fire rating equal to that of construction being penetrated.

Install only after substrate penetrations and supporting brackets have been installed. Do not install firestopping when ambient or substrate temperatures are outside limits permitted by manufacturers or when substrates are wet. Where floor openings without penetrating items are more than 4 inches wide and subject to traffic or loading, install firestopping materials capable of supporting same loading as floor. Protect materials on surfaces subject to traffic.

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SMOKE-RESISTIVE SYSTEMS

The space around items penetrating non-fire rated walls and floors shall be filled with an approved material to limit the free passage of smoke, heat and flame in locations including, but not limited to, the following:

Penetrations through non-rated floors including both empty openings and openings containing penetrants.

Penetrations through non-rated smoke partitions and wall assemblies including both empty openings and openings containing penetrants.

WALL AND FLOOR ACCESS DOORS

Comply with manufacturer's instructions for installation of access doors, floor doors, and removable access plates.

Set frames accurately in position and securely attach to supports with face panels plumb or level in relation to adjacent finish surfaces.

Adjust hardware and panels after installation for proper operation.

Remove or replace panels or frames that are warped, bowed, or otherwise damaged.

PATCHING

Repair, patching, and finishing of walls, floors, and/or ceilings affected by demolition, cutting after installation of new work, etc. shall be done by technicians skilled in the applicable trades and shall match surrounding or adjoining materials in composition, texture, color, and finish.

CONTRACTOR AS-BUILT DRAWINGS

Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.

Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.

Accurately record information in an acceptable drawing technique.

Record data as soon as possible after obtaining it.

Record and check the markup before enclosing concealed installations.

Cross-reference record prints to corresponding archive photographic documentation.

Types of items requiring marking include, but are not limited to, the following:

Dimensional changes.

Revisions to details.

Locations and depths of underground utilities.

Revisions to routing of piping and conduits.

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Revisions to electrical circuitry.

Actual equipment locations.

Duct size and routing.
Locations of concealed internal utilities.

Additional information that was either shown schematically or omitted from original Drawings.

Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

Submit Contractor As-built Drawings to A/E for review **at least two (2) weeks prior to Project final inspection**.

END SECTION 019913

Docusign Envelope ID: A708AC2D-32EE-419A-BBBD-70DD021DD26A

SUBMITTAL COVER FORM

PROJECT: NCMA East Building and Museum Park Improvements
NC Department of Natural and Cultural Resources

PROJECT NO.: SO#2022-03941

TO: SALAS O'BRIEN NORTH CAROLINA, INC.
702 Oberlin Road, Suite 300
Raleigh, NC 27605

FROM: _____

_____

_____

_____

_____ CONTRACTOR _____ SUBCONTRACTOR

We submit for your consideration the following product for the above project:

SPECIFICATION SECTION	SPECIFICATION PARAGRAPH	DESCRIPTION

TYPE OF SUBMITTAL:

_____ Specified Brand Product
_____ Proposed Equivalent Product to Specified Brand
_____ Product Meeting Performance Specification (No Brand Specified)

We warrant the following:

a. We have personally investigated the proposed product, and determined that it is equal in all respects to that specified and/or performance specification requirements;

b. We will provide the specified guarantee for this product;

c. We will coordinate installation of this product into the work, making such changes as may be required for the work to be complete in all respects;

d. We have clearly indicated by marking as "Non-Complying Feature" each and every requirement of the Specifications that this product does not meet;

e. And, we waive all claims for additional costs related to this product which subsequently become apparent.

Attached hereto are complete technical data, including applicable laboratory reports, to demonstrate compliance with project requirements.

SUBMITTED BY:

_____ _____
SIGNATURE DATE

Docusign Envelope ID: A708AC2D-32EE-419A-BBBD-70DD021DD26A

SUBMITTAL REVIEW

(SAMPLE FORM - ORIGINAL WITH COMMENTS WILL BE ATTACHED TO SUBMITTAL BY A/E)

PROJECT:

PROJECT #:

SUBMITTAL ID#:

SPECIFICATION PARAGRAPH:

DESCRIPTION:

Submittal has been reviewed only for conformance with design intent of the contract documents. See Section 019913 "GENERAL REQUIREMENTS FOR ENGINEERED WORK" for complete definition of Submittal Review.

- ☐ Reviewed
- ☐ Exceptions Noted - Revise & Proceed
- ☐ Exceptions Noted - Revise & Resubmit
- ☐ Rejected

DATE:

BY:

REVIEW COMMENTS:

THESE COMMENTS SHALL NOT BE REMOVED FROM THIS DOCUMENT

Docusign Envelope ID: A708AC2D-32EE-419A-BBBD-70DD021DD26A

SECTION 019916 - DIVISIONS 21-28 WORK IN EXISTING BUILDINGS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification sections, apply to this section.

SUMMARY

Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification sections, apply to this section.

The requirements specified herein shall govern all Sections in Divisions 21-28, whether stated therein or not.

Where items specified in the other sections of this Division conflict with requirements of this Section, the former shall govern.

SUBMITTALS

Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

DEFINITIONS

Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.

Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner.

Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.

Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

MATERIALS OWNERSHIP

Unless otherwise indicated, demolition waste becomes property of Contractor. Materials removed during demolition shall be accumulated in the demolition area for examination by the Owner. The Owner may choose to retain selected items. Items not selected to be retained by the Owner become the property of the Contractor and shall be removed from the site in a timely manner. All disposal fees and/or permits shall be the responsibility of the Contractor.

QUALITY ASSURANCE

Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved Section 608 certification program.

FIELD CONDITIONS

Existing facilities shall remain in use during all phases of construction under this Contract. **All and any of existing building safeties such as exit signage, exit lights, fire alarm, fire sprinkler etc., must remain operational CONTINUOUSLY in order to retain building occupancy status. All required exits and exit signs must be kept available and free of obstruction at all times.** The Contractor shall cooperate with the Owner in every way possible to keep interruption of, and interference with, normal functions, activities, and operations to a minimum.

Where construction or attendant work interrupts normal functions in any area, a schedule of work shall be submitted for approval of the Owner and after approval, strictly followed. Modification to existing work shall be done as required. All work shall be performed in such a manner as to prevent any interruption of any service or utility. Where it is necessary to interrupt service for demolition, cut-in, or changeover, the work shall be scheduled well in advance of the interruption and the interruption approved by the Owner. As required by the Owner, such work shall be done during night, weekends, holidays, or other off peak period as approved.

Existing piping, ductwork, raceway and wiring, etc., shall be modified as indicated on the Drawings and/or as required by new and modified construction. Existing piping, ductwork, raceway and wiring, etc., shall be modified as required and put in first class operating condition. No equipment shall be disconnected without approval of the Owner's Representative. Temporary relocation of equipment and temporary piping, ductwork, wiring and raceway, etc., required for continued operation of the facility shall be provided as required.

ASBESTOS WARNING

Asbestos and asbestos containing materials are often encountered during the process of renovations or in the performance of site work in or in the vicinity of existing structures. Under no circumstances will the Contractor disturb asbestos or asbestos containing material.

Suspect Materials - Contractor to Notify: It is the Contractor’s responsibility to notify the Owner and the A/E immediately should suspect materials be encountered during construction activities. In the event suspect asbestos or asbestos containing materials are encountered, the Contractor shall immediately cease all work in the area and secure the involved area to prevent inadvertent contamination or exposure. The Owner or the Owner’s agent will conduct testing of suspect materials and notify the Contractor in writing when work in the affected area may resume.

Contractor Responsible for Contamination: The Contractor is enjoined to use extreme caution in the performance of construction activities in the vicinity of asbestos or asbestos containing materials. The Contractor shall bear the total and complete expense, including expenses incurred for decontamination, fines, penalties and incidental expense due to loss of use of the facility resulting from any improper work involving asbestos or asbestos containing materials.

LEAD BASED PAINT WARNING

Lead based paint and/or other lead containing materials are often encountered during the process of renovations or in the performance of site work in or in the vicinity of existing structures. The Contractor may be required to work with these materials during the normal course of the construction process.

OSHA Compliance is Contractor’s Responsibility: It is the Contractor’s responsibility to comply with all OSHA requirements during the construction process. Specific attention is drawn to OSHA Standard 1926.62, Subpart D, titled “LEAD” (29 CFR 1910) during work with all lead-containing materials.

Testing by Contractor: The Contractor is hereby notified that lead based paint testing may be necessary to comply with OSHA requirements.

The determination of the need for testing and the cost associated with such testing as necessary to comply with OSHA requirements is a construction activity and shall be provided by the Contactor at no additional cost to the Owner.

Contractor Responsible for Contamination: The Contractor is enjoined to **use extreme caution** in the performance of construction activities in the vicinity of lead-based paint, lead-containing paint, or lead-containing materials. The Contractor shall bear the total and complete expense, including expenses incurred for decontamination, fines, penalties and incidental expense due to loss of use of the facility resulting from any improper work involving lead or lead containing materials.

ROOFING WARRANTIES

Existing Warranty: *Remove, replace, patch, and repair materials and surfaces during roofing repairs by methods and with materials so as not to void existing roofing system warranty*. Notify warrantor before proceeding. Notify warrantor of existing roofing system on completion of reroofing, and obtain documentation verifying that existing roofing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

New Warranty: All new roofing work shall be guaranteed for five (5) years.

PART 2 - PRODUCTS NOT USED

PART 3 - EXECUTION

PERFORMANCE REQUIREMENTS

Comply with governing EPA notification regulations before beginning selective demolition.

Comply with hauling and disposal regulations of authorities having jurisdiction.

EXAMINATION AND PREPARATION

Verify that utilities have been disconnected and capped, valved off, or otherwise secured before starting demolition.

Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to the A/E.

Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain. As necessary, provide dust barriers, noise control, etc. to minimize impact of demolition on adjacent occupied areas.

Provide protection to ensure safe passage of people around demolition area and to and from occupied portions of building.

Provide temporary weather protection, during interval between demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.

Provide heating, cooling, dehumidification, and ventilation as necessary to protect the existing building materials and finishes during the demolition period.

Where existing plumbing, fire protection, HVAC, or electrical services in demolition areas must be shutdown, temporary plumbing, fire protection, heating, cooling, dehumidification, ventilation, lighting, and electrical power shall be provided as needed to maintain use of adjacent occupied areas that are negatively impacted by the shutdown.

Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.

Cover and protect furniture, furnishings, and equipment that have not been removed.

Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

GENERAL CONSTRUCTION DEMOLITION

Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.

Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and/or portable fire-suppression devices, as required, during flame-cutting operations.

Maintain adequate ventilation when using cutting torches.

Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.

Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.

Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

Dispose of demolished items and materials promptly.

Protect construction indicated to remain against damage and soiling during demolition.

MECHANICAL DEMOLITION

Remove or relocate all mechanical elements (devices, fixtures, controls, etc.) from walls or floors indicated as being demolished.

Thermostats and sensors containing mercury shall be disposed in accordance with EPA Resource Conservation and Recovery Act (RCRA). Contractor shall refer to EPA web site for handling procedures for disposal and spill management of projects containing mercury.

Extend or relocate any existing piping and or ductwork serving existing equipment to remain or other items where such circuits are disrupted due to demolition.
Remove all abandoned piping back to the point of supply or back to the point where other remaining piping is connected. For existing piping imbedded existing walls or floors that are not to be demolished, remove piping to behind finish surface, cap, and patch wall or floor as specified hereinafter.

Existing HVAC systems serving both occupied areas and construction areas shall be modified as required to isolate the construction area. Ducts shall be sealed by closing dampers, disconnecting ducts and sealing openings with 6-mil polyvinyl sheeting, etc.
HVAC equipment in construction areas that is required to be reused shall be de-energized and protected from construction dust and debris with 6-mil polyvinyl sheeting during construction. HVAC systems that are modified during renovation shall be sealed until modifications are made and then resealed until start-up is required. After unsealing of equipment, coils and drain pans of air-handling equipment shall be cleaned.

Recover and recycle refrigerants from existing equipment to be demolished. All demolition work of existing systems containing refrigerant must be conducted in accordance with Section 608 of EPA Clean Air Act under supervision of an EPA certified technician. Provide documentation with types, quantities and dates for the engineers and owners record.

Control or monitoring systems that protect equipment and/or occupants must be maintained until associated equipment is removed.

ELECTRICAL DEMOLITION

Coordinate all electrical outages with the Owner to facilitate reworking of existing system. No service, feeder, or branch circuit may be de-energized unless specific approval has been obtained from the Owner's representative.

Dispose of Removed Equipment and Material: Materials removed and not indicated by Drawings to be reinstalled, stored, or retained by the Owner, shall be removed from the site in a timely manner at the Contractor's expense.

The Owner may choose to retain selected items or equipment. The Contractor shall remove and deliver such items and/or equipment to a location on site as requested by the Owner.

Thoroughly inspect electrical systems in reworked areas and bring to the attention of the A-E all defective or unserviceable material not scheduled for removal or replacement.

Remove all abandoned wiring, both exposed and concealed.

Remove all abandoned raceway and any related items, both exposed and concealed. Where existing raceway is concealed in concrete or masonry, remove wiring as required above and abandon in place. Cut abandoned raceway off ½" into wall, ceiling, or floor to allow patching to completely cover cut off end of raceway.

Repair surfaces and finishes to match existing surrounding surfaces or finish in all areas where items are removed. After repairs are made no evidence of previous use of surfaces shall be visible.

Provide touch-up painting as required where new items are installed adjacent to existing items to remain.

Clean new, damaged, and/or disturbed areas and apply primer, intermediate, and finish coats at each location.
Surface preparation and timing of application of successive coats of paint shall be in accordance with paint manufacturer’s instructions.

Use zinc-rich paint to repair damage to galvanized finishes. Follow written instructions of paint manufacturer.

Repair paint finishes for other items, surfaces, or equipment as necessary. Follow written instructions of paint manufacturer.

Provide blank cover plates to match device plates used in the adjoining areas where outlet, device, junction, or other boxes are to remain,

Perform the electrical demolition as described below:

Remove all electrical raceway, cable, wiring, devices, junction boxes, fittings, and related items from all locations indicated on the Drawings as being renovated. Existing raceway, junction boxes, fittings, and similar items may only be reused for the present project where explicitly indicated on the Drawings, provided:

The existing item is in good condition and is suitable for reuse.

The existing items meets the requirements of the Specifications for similar items which might be provided new in other locations on the project. Additional support and/or fire stopping may be required to meet this condition.

The existing item is located in the same position as required in the new configuration as shown on the Drawings.

Extend or relocate all existing circuits and related items serving existing utilization or other equipment where such circuits or items are disrupted due to demolition activities of any division of the Contract Documents. Relocate all existing junction boxes or similar items that will be rendered inaccessible by new construction furnished under any division of the Contract Documents. Provide any and all temporary electrical supply (supplies) as needed to meet this requirement.

Remove all abandoned circuits back to the point of supply or back to the point where other remaining loads are connected. Label any unused overcurrent devices as “SPARE”. Circuits supplying equipment which is removed or demolished by any division of the Contract Documents is considered as “abandoned” for purposes of this requirement.

Revise existing panel directories to reflect modifications made as a part of the project. All directory revisions shall be typed.

LIGHT FIXTURE DISPOSAL

Lighting fixtures shall be expected to contain ballasts containing Polychlorinated Biphenyls (PCB's). The Contractor shall dispose of these ballasts by collecting them in metal drums, and shall transport these drums to an approved disposal site. The Contractor's responsibility shall be to properly collect the ballasts and turn them over to a hazmat disposal facility.

On all fixtures to be demolished the Contractor shall open the wiring compartments of the lighting fixture and determine if the lighting fixture contains ballast(s) with Polychlorinated Biphenyls (PCB's.) Non PCB-containing ballasts will have printed on their labels "NO PCB's". If the ballast label is missing, illegible, or not explicitly labeled "NO PCBs," the ballast shall be considered to contain PCBs. Ballasts explicitly stating "NO PCBs" shall be disposed of by the Contractor as a part of the normal demolition of material in the project. All other ballasts (missing labels, illegible labels, or those ballasts not explicitly marked "NO PCBs") shall have their wires cut close to the ballasts and be removed from the lighting fixtures.

In addition, Contractor shall expect that all lamps contain mercury. The Contractor shall dispose of these lamps by collecting them in a manner that keeps the lamps intact and turn them over to a properly permitted light recycler.

END OF SECTION 019916

SECTION 019919 - EXCAVATION FOR DIVISIONS 21 - 28 WORK

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification sections, apply to this section.

The requirements specified herein shall govern all Sections in Divisions 21-28, whether stated therein or not.

Where items specified in the other sections of this Division conflict with requirements of this Section, the former shall govern.

SUMMARY

This section address trenching and backfilling for the installation of underground mechanical piping and/or electrical raceway provided under Divisions 21-28.

PROJECT CONDITIONS

Protect property from any and all damage that might result from excavating and backfilling.

Protect persons from injury at excavations, by barricades, warnings and illumination.

Coordinate excavations with weather conditions, to minimize possibility of washouts, settlements and other damages and hazards.

PART 2 - PRODUCTS

DIRECT BURY WARNING TAPE

Tape shall be 0.004 inch thick, 6 inches wide, yellow polyethylene with a ferrous metallic core, acid and alkali-resistant and shall have a minimum strength of 1750 psi lengthwise and 1500 psi crosswise with an elongation factor of 350 percent. Provide bold black letters on the tape identifying the type of system. Tape color and lettering shall be unaffected by moisture and other substances contained in the backfill material.

PART 3 - EXECUTION

TREE CONSERVATION

Provide a fenced, tree protection area around all trees within the excavation area. **In no case shall excavation take place within the outmost edge of branches above, referred to as the "drip line".** Fencing shall be constructed of metal poles with orange plastic barricade or wood tree protecting fencing. Every 50 linear feet of tree protection fence shall have a sign that says “Tree Protection Fence” using 3” minimum height black letters on white background. At least one sign is required.

No materials, equipment, or people may enter into the tree protection area. Allow no poisoning to trees with the dumping of materials such as solvents, gas, paint, and herbicides or with the washing of toxic materials into the tree protection area. Exercise care that no runoff from clean up operations (including concrete clean up wash water) enters the tree protection areas.

Where required excavation occurs in the immediate vicinity of a tree protection boundary, work shall proceed in the following manner: Prior to grading or digging in the critical root zone of protected trees, root prune the tree to avoid the ripping of roots with digging equipment. This may be accomplished with a trencher. Any roots larger than ½" that are damaged due to cut grading or trenching operations must be stubbed cleanly.

EXCAVATION SUPPORT AND PROTECTION

Furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads.

Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

Shore, support, and protect utilities encountered during excavation.

Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.

Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

EXCAVATION FOR UTILITY STRUCTURES

Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. As required, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections. Do not disturb bottom of excavations intended as bearing surfaces.

At edges of tree- and plant-protection zones, excavate by hand to indicated lines, cross sections, elevations, and sub-grades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

EXCAVATION FOR UTILITY TRENCHES

Do not excavate for electrical work until the work is ready to proceed without delay, so that total time lapse from excavation to completion of backfilling will be minimized.

Excavate trenches to indicated gradients, lines, depths, and elevations.

Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit.

Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.

Provide 12 inches clearance each side of pipe or conduit unless indicated otherwise.

Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

For pipes and conduit less than 6 inches in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.

For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.

For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.

Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

For trenches in tree- and/or plant-protection zones, hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.

STORAGE OF SOIL MATERIALS

Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

DEWATERING

Prevent surface water and ground water from entering excavations. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

BACKFILL

Place backfill on sub-grades free of mud, frost, snow, or ice.

Backfill voids with satisfactory soil while removing support and protection systems.

Trench backfill:

Backfill excavations in 8" high courses of backfill material, uniformly compacted to the following densities (% of maximum density, ASTM D 1557), using power-driven hand-operated compaction equipment.

Lawn/Landscaped Areas: 85% for cohesive soils; 90% for cohesionless soils.

Paved Areas, Other Than Roadways: 90% for cohesive soils; 95% for cohesionless soils.

Roadways: 90% for cohesive soils; 95% for cohesionless soils.

Backfill trenches with concrete where trench excavations pass within 18" of column or wall footings and which are carried below bottom of such footings, or which pass under wall footings. Place concrete to level of bottom of adjacent footing.

Do not backfill trenches until tests and inspections have been made and backfilling authorized by A-E. Use care in backfilling to avoid damage or displacement of piping, conduit, etc.

Place and compact bedding course on trench bottoms as indicated on the Drawings. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.

Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

Install warning tape directly above utilities, 12 inches below finished grade. See Sections 221125 and 221126 for special underground gas piping identification requirements, as applicable.

DISPOSAL OF SURPLUS AND WASTE MATERIALS

Remove surplus soil and waste materials, including unsatisfactory soil, trash, and construction debris, and legally dispose of them off Owner's property.

END OF SECTION 019919

SECTION 019926 - OWNER INSTRUCTION AND TRAINING FOR DIVISIONS 21-28 WORK

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification sections, apply to this section.

The requirements specified herein shall govern all Sections in Divisions 21-28, whether stated therein or not.

Where items specified in the other sections of this Division conflict with requirements of this Section, the former shall govern.

QUALITY ASSURANCE

The Owner instruction and training program shall be developed and coordinated by a firm or individual experienced in training or educating maintenance personnel.

Contractor personnel experienced in the systems and components incorporated in this Project, along with factory-authorized service representatives, shall perform the instruction.

COORDINATION

Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.

Coordinate content of training modules with content of manufacturers' recommended emergency, operation, and maintenance procedures.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Instructional Program and Instructional Materials: Submit detailed description of instructional program structure, training modules, and instructional materials.

Instructor Qualifications: Submit curriculum vitae for each instructor, specifically defining the experience of each instructor and the training modules for which he or she shall be responsible.

PART 2 - PRODUCTS

INSTRUCTION PROGRAM

General: **The Contractor(s) for each of Divisions 21-28, as applicable, is responsible for instructing Owner's personnel relative to each Division's work**, including the following:

Instruction in the operation of systems, subsystems, and equipment.

Training in maintenance of systems, subsystems, and equipment.

Program Structure: Develop an instruction and training program that includes individual training modules for each Division 21-28 system, subsystem, and equipment item, including both classroom instruction and "hands-on" demonstrations.

Training Modules: Develop a learning objective and teaching outline for each instruction and training module, taking into consideration the level of proficiency of Owner's maintenance staff. Include a description of specific skills and knowledge that each participant is expected to master.

For each instruction and training module, include instruction for the following, as applicable to the system, subsystem, equipment, or component:

Documentation: Review the following items in detail:

Operations manuals.

Maintenance manuals.

Project record documents.

Warranties, bonds, and guarantees.

Maintenance service agreements and similar continuing commitments.

Emergencies: Include the following, as applicable:

Instructions on meaning of warnings, trouble indications, and error messages.

Shutdown instructions for each type of emergency.

Operating instructions for conditions outside of normal operating limits.

Sequences for electric or electronic control systems.

Special operating instructions and procedures.

Operations: Include the following, as applicable:

Startup procedures.

Equipment or system break-in procedures.

Routine and normal operating instructions.

Regulation and control procedures.

Control sequences.

Safety procedures.

Normal start-up and shutdown instructions.

Operating procedures for emergencies.

Operating procedures for system, subsystem, or equipment failure.

Required sequences for electric or electronic control systems.

Special operating instructions and procedures.

Adjustments: Include the following:

Alignments.

Routine adjustments, tightening, etc.

Noise and vibration adjustments.

Economy and efficiency adjustments.

Maintenance: Demonstrate the following:

Inspection procedures.

Preventative maintenance requirements, consisting of the following:

Routine maintenance, which consists of specific procedures that are performed on a regular schedule and are designed to detect, preclude, or mitigate degradation of a system or its components.

Predictive maintenance, which uses routine inspection and evaluation, testing, and analysis to augment routine maintenance procedures by detecting the onset of component degradation and to address problems as they are identified.

Instruction on use of special tools.

Repairs: Include the following:

Troubleshooting and diagnostic instructions.

Test and inspection procedures.

Repair instructions.

Disassembly; component removal, repair, and replacement; and reassembly instructions.

Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

Owner will furnish an instructor to describe Owner's operational philosophy.

Owner will furnish Contractor with names and positions of participants to attend instruction and training, not to exceed 10 individuals.

Confirm Topics and Agenda with owner prior to scheduling.

Provide instruction at mutually agreed on times scheduled at least four (4) weeks in advance through the A/E. For systems, subsystem, and/or equipment that requires seasonal operation, provide required instruction at start of each season.

Conduct training on-site in the completed and fully operational facility in classroom/conference space provided by the Owner and using the actual systems, subsystems, and equipment installed.

Conduct training using final operation and maintenance data submittals as the training reference material. If additional training materials are utilized, they shall be incorporated as an appendix to the operation and maintenance data submittals.

Provide documentation that Owner instruction and training has taken place. Provide record of dates, topics, and duration of each training session, the names of Owner's staff who participated, and a signed review form by each participant.

END OF SECTION 019926

SECTION 024119 - SELECTIVE DEMOLITION

GENERAL

RELATED DOCUMENTS

a. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

SUMMARY

b. This Section includes the following:

1) Demolition and removal of selected site elements.
2) Salvage of existing items to be reused or recycled.

b. Related Sections include the following:

1) Division 01 Section "Summary" for use of premises, phasing, and Owner-occupancy requirements.
2) Division 01 Section "Project Management and Coordination" for predemolition conference.
3) Division 01 Section "Temporary Facilities and Controls" for temporary construction and environmental-protection measures for selective demolition operations.
4) Division 31 Section "Site Clearing" for site clearing and removal of above- and below-grade improvements.

DEFINITIONS

a. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.

a. Remove and Salvage: Detach items from existing construction and deliver them to Owner.

b. Remove and Reinstall; Relocate: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.

c. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled or relocated.

SUBMITTALS

a. Schedule of Selective Demolition Activities: Indicate the following:

1) Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
2) Interruption of utility services. Indicate how long utility services will be interrupted.
3) Coordination for shutoff, capping, and continuation of utility services.
4) Means of protection for items to remain and items in path of waste removal from project site.

QUALITY ASSURANCE

a. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.

a. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

b. Standards: Comply with ANSI A10.6 and NFPA 241.

a. Predemolition Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to selective demolition including, but not limited to, the following:

1) Inspect and discuss condition of construction to be selectively demolished.
2) Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
3) Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
4) Review areas where existing construction is to remain and requires protection.

PROJECT CONDITIONS

a. Notify Engineer of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

a. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.

1) If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Engineer and Owner.

b. Storage or sale of removed items or materials on-site is not permitted.

c. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

WARRANTY

a. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

PRODUCTS (NOT USED)

EXECUTION

EXAMINATION

b. Verify that utilities have been disconnected and capped.

c. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

d. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.

e. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Engineer.

UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

a. Existing Services/Systems: Maintain services/systems indicated to remain and protect them against damage during selective demolition operations.

    1) Comply with requirements for existing services/systems interruptions specified in Division 01 Section "Summary."

a. Service/System Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.

    1) Contractor to coordinate with Owner and arrange to shut off indicated services/systems.
    1) Arrange to shut off indicated utilities with utility companies.
    2) If services/systems are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to buildings.

PREPARATION

b. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1) Comply with requirements for access and protection specified in Division 01 Section "Temporary Facilities and Controls."

a. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1) Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.

SELECTIVE DEMOLITION, GENERAL

b. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations.

a. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Engineer, items may be removed to a suitable, protected storage location during selective demolition and reinstalled in their original locations after selective demolition operations are complete.

SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

a. Concrete and Asphalt adjacent to areas not disturbed with NCMA Vision Plan – Phase One. Coordinate with Engineer on specific locations. Demolish in sections. Cut concrete/asphalt full depth at junctures with construction to remain and at regular intervals, using power-driven saw, then remove concrete/asphalt between saw cuts.

DISPOSAL OF DEMOLISHED MATERIALS

a. General: Except for items or materials indicated to be recycled, reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.

1) Do not allow demolished materials to accumulate on-site.
2) Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

a. Burning: Do not burn demolished materials.

a. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

CLEANING

b. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

SELECTIVE DEMOLITION SCHEDULE (NOT USED)

PART 39 - END OF SECTION 024119

SECTION 024119 - SELECTIVE DEMOLITION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Demolition and removal of selected portions of building or structure.
   2. Salvage of existing items to be reused or recycled.

B. Related Requirements:
   1. Section 011000 "Summary" for restrictions on use of the premises, Owner-occupancy requirements, and phasing requirements.

1.2 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

1.3 PREINSTALLATION MEETINGS

A. Pre-demolition Conference: Conduct conference at Project site.
   1. Inspect and discuss condition of construction to be selectively demolished.
   2. Review structural load limitations of existing structure.
   3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
   4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
   5. Review areas where existing construction is to remain and requires protection.

1.4 INFORMATIONAL SUBMITTALS

A. Engineering Survey: Submit engineering survey of condition of building.

B. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control. Indicate proposed locations and construction of barriers.

C. Schedule of Selective Demolition Activities: Indicate the following:
   1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's other tenants' on-site operations are uninterrupted.
   2. Use of elevator and stairs.
   3. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.

D. Pre-demolition Photographs: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by salvage and demolition operations. Comply with Section 013233 "Photographic Documentation." Submit before Work begins.

1.5 CLOSEOUT SUBMITTALS

A. Inventory: Submit a list of items that have been removed and salvaged.

1.6 FIELD CONDITIONS

A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials: Present in buildings and structures to be selectively demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
   1. Hazardous material noted in Construction Documents are to be removed by the Contractor. No prior demolition will be done before the project is started.
   2. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.

E. Storage or sale of removed items or materials on-site is not permitted.

F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
   1. Maintain fire-protection facilities in service during selective demolition operations.

1.7 COORDINATION

A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI/ASSP A10.6 and NFPA 241.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that applicable utilities have been disconnected and capped before starting selective demolition operations.

B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.

C. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.
   1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

D. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

E. Survey of Existing Conditions: Record existing conditions by use of measured drawings and preconstruction photographs or video.
   1. Comply with requirements specified in Section 013233 "Photographic Documentation".
   2. Inventory and record the condition of items to be removed and salvaged.
   3. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.

3.3 PROTECTION

A. Revise "Temporary Protection" Paragraph below to suit Project. Delete if adequately covered in Section 015000 "Temporary Facilities and Controls."Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
   1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
   2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
   3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
   4. Cover and protect furniture, furnishings, and equipment that have not been removed.
   5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Temporary Facilities and Controls."

B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
   1. Strengthen or add new supports when required during progress of selective demolition.

C. Remove temporary barricades and protections where hazards no longer exist.

3.4 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
   1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
   2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
   3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
   4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
   5. Maintain fire watch during and for at least 2 hours after flame-cutting operations.
   6. Maintain adequate ventilation when using cutting torches.
   7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
   8. Remove structural framing members and lower to ground by method suitable to avoid

free fall and to prevent ground impact or dust generation.

9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
10. Dispose of demolished items and materials promptly. Comply with requirements of Supplementary General Conditions.

B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

C. Removed and Salvaged Items:
1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner's storage area designated by Owner.
5. Protect items from damage during transport and storage.

D. Removed and Reinstalled Items:
1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.5 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.
1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

B. Burning: Do not burn demolished materials.

3.6 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 024119

SECTION 030130 - STRENGTHENING OF CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 DESCRIPTION

A. This specification section shall define the minimum requirements of the externally bonded composite strengthening system.

1.2 REFERENCES

A. General.
   1. The latest reference edition available on the day of bid invite shall be used for all standards.

B. American Concrete Institute (ACI).
   1. ACI 440.2R, Guide for the Design and Construction of Externally Bonded FRP Systems for Strengthening of Concrete Structures.
   2. ACI 562, Code Requirements for Evaluation, Repair and Rehabilitation of Concrete Buildings.
   3. ACI Repair Application Procedures (RAP) No. 1 through No.7.

C. American Society for Testing and Materials (ASTM).
   1. ASTM D3039, Standard Test Method for Tensile Properties of Polymer Matrix Composite Material.
   2. ASTM D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
   3. ASTM D4541, Standard Test Method for Pull-Off Strength for Coatings Using Portable Adhesion Testers.
   4. ASTM D7522, Standard Test Method for Pull-Off Strength for FRP Bonded to Concrete Substrate.
   5. ASTM D7565, Standard Test Method for Determining Tensile Properties of Fiber Reinforced Polymer Matrix Composites Used for Strengthening of Civil Structures.
   6. ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

D. International Concrete Repair Institute (ICRI).
   1. ICRI Technical Guideline No. 310.1R, Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion.
   2. ICRI Technical Guideline No. 310.2R, Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.
   3. ICRI Technical Guideline No. 320.2R, Guide for Selecting and Specifying Materials for Repair of Concrete Surfaces.
   4. ICRI Technical Guideline No. 210.3R, Guide for Using In-Situ Tensile Pulloff Tests to Evaluate Bond of Concrete Surface Materials.

5. ICRI Technical Guideline No. 210.1R, Guideline for Verifying Field Performance of Epoxy Injection of Concrete Cracks.

E. ICC Evaluation Service (ICC-ES).
1. AC125, Acceptance Criteria for Concrete and Reinforced and Unreinforced Masonry Strengthening using Externally Bonded Fiber-Reinforced Polymer (FRP) Composite System.
2. AC178, Acceptance Criteria for Inspection and Verification of Concrete and Reinforced and Unreinforced Masonry Strengthening using Fiber-Reinforced Polymer (FRP) Composite Systems.

1.3 MEASUREMENT AND PAYMENT

A. The composite strengthening system shall be bid as a lump sum and is to include all costs associated with the work defined in this specification section. This includes the furnishing of all submittals, materials, tools, equipment, labor, surface preparation, transportation, storage, and supervision required for the application of the FRP materials.

1.4 SUBMITTALS

A. Manufacturers' Product Data.
1. Current ICC Evaluation Service Report for the proposed materials.
2. Technical data sheets for materials to be used.
3. Safety data sheets (SDS) for each material component.
4. Installation instructions, including temperature restrictions, moisture limitations, surface preparation methods, curing times, and finish requirements.
5. The manufacturer shall clearly define the adhesive resin working time. Any batch that exceeds the batch life shall not be used.
6. Provide test report for Class 1 Flame & Smoke per ASTM E84.
7. Written verification from the manufacturer that their applicator has received the required certifications and training.

B. Calculations and Drawings.
1. Design calculations and shop drawings for the composite system shall be compliant with ACI 440.2R and must be stamped and signed by Civil or Structural Engineer registered in the state of North Carolina.
2. Design calculations must also conform to ACI 562 Equations 5.5.2a, 5.5.2b, and 5.5.3 that stipulate the strength of the unstrengthened structure must be at least equal to the load combinations specified in section 5.5.2.
3. Shop drawings, at a minimum, must detail the necessary surface preparation, composite system to be used, number of layers, locations, end details, primary fiber direction, and finish requirements.

C. Applicator Qualification.
1. Written documentation from the composite system manufacturer that the contractor has completed the manufacturer's training program and has been trained to install the proposed system.

2. Submit a list of completed surface bonded FRP composite strengthening projects completed with the manufacturer's FRP composite system in the past 3 years. The list should include at a minimum 30 projects with proposed FRP system, the dates of work, type, description and amount of work performed.
3. Surface bonded FRP composite system shall be installed by certified applicator with written consent from manufacturer that the contractor has been trained. Certified applicator shall have a minimum of 5 years experience in performing FRP composite retrofits.
4. The Engineer may suspend the work if the Contractor substitutes an unapproved fiber reinforced composite system or unapproved personnel during construction.

D. The special inspector must complete the Manufacturer’s installation training procedure and submit certification of successful completion.

E. The special inspector must submit a letter indicating full understanding of the all the requirements of ICC ES (ACI 78), signed and sealed by a professional engineer in the State of North Carolina.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. All products shall be delivered, stored, and handled according to the manufacturer’s recommendations.

B. Materials shall be clearly labeled and delivered in factory-sealed containers with manufacturing dates and shelf lives easily identifiable.

C. Materials shall be stored in a protected area free of moisture and UV exposure, with temperatures between 45°F and 95°F.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURER & COMPOSITE STRENGTHENING SYSTEMS

A. Composite Strengthening System™ supplied by Simpson Strong-Tie®, Inc., 5956 W. Las Positas Boulevard, Pleasanton, CA 94588, Phone: 925.560.9000, Fax: 925.847.1605.
1. Fabrics.
   a. CSS-CUCF11: Code listed, unidirectional carbon fabric.
   b. CSS-CUCF22: Code listed, unidirectional carbon fabric.
   c. CSS-CUCF44: Code listed, unidirectional carbon fabric.
2. Epoxy Adhesive.
   a. CSS-ES: Epoxy saturant and primer.
3. Epoxy Paste.
   a. CSS-EP: Epoxy paste and filler.
   b. CSS-ES thickened with fumed silica: Epoxy paste and filler.
   c. FX-702: Oven-Dried Rounded Silica Filler.
4. Coating.
   a. FX-207: Slurry Seal.

b. FX-505: Water-Based Acrylic Coating.

B. V-Wrap FRP Strengthening System(s) supplied by Structural Technologies (10150 Old Columbia Rd, Columbia, MD 21046. Tel: 410-850-7000, Fax: 410-850-4111) Products include:
   1. Composite fabric:
      a. V-Wrap C100 high strength carbon fiber sheets.
      b. V-Wrap C200 high strength carbon fiber sheets.
      c. V-Wrap C400 high strength carbon fiber sheets.
   2. Epoxy saturant/primer: V-Wrap 700 is used as a primer and is also combined with the fiber to form the V-Wrap system.
   3. Filler: Thickened V-Wrap 700 for protective seal coat, filling voids and primer where needed.

C. Tyfo Fibrwrap System(s) supplied by Fyfe Co. LLC 4995 Murphy Canyon Road, Suite 110, San Diego, CA 92123. Tel: 858-642-0694, Mid-Atlantic Representative: Dennis Dempsey; (410) 299-4167; Products include:
   1. Fabics.
      a. Tyfo SCH fiber - primary carbon fiber, unidirectional.
      b. Tyfo SEH fiber - primary glass fiber, unidirectional.
      c. Alternate primary carbon or glass fiber systems available upon request.
   2. Epoxy Adhesive.
      a. Epoxy saturant/primer: Tyfo® S epoxy is used as a primer and is also combined with the fiber to form the Tyfo Fibrwrap System.
   3. Filler.
      a. Primer/Filler: Thickened Tyfo® S, thickened epoxy for protective seal coat, filling voids and primer where needed. Field thickened epoxy may be used to patch “bugholes” up to 1.5” in depth and to fill voids.
   4. Finishes:
      a. Detailing Finish: Thickened Tyfo® S epoxy shall be applied to all seams and edges.
      b. Fire Protection Finish (if required): Tyfo® RR for Class A flame and smoke (ASTM E84), interior finish rating. Tyfo® CFP for 1-to-4-hour UL rated assembly (ASTM E119).
      c. Aesthetic Finish: Two-coats of either acrylic or polyurethane paint (approved by the owner).
      d. Alternate finishes must be approved by the Owner and Manufacturer.

D. Approved alternate FRP manufacturer. Alternate FRP systems must provide all items listed in Section 1.04 of this specification; otherwise, they shall be considered non-compliant.

PART 3 EXECUTION

3.1 CONCRETE REPAIR PRIOR TO FRP INSTALLATION

A. All problems associated with the condition of the original concrete substrate should be addressed before surface preparation begins. This section details approved concrete repair products and procedures.

B. Before repairing the concrete, contractor shall remove all loose or deteriorated concrete by high-pressure water jetting or other mechanical means to reach sound concrete. If reinforcing steel is exposed, contractor shall remove all concrete behind the reinforcing steel following ICRI Technical Guideline 310.1R.

C. Cracks in the areas where loose or deteriorated concrete have been removed or in areas where the FRP will be installed shall be repaired using a crack repair system for non-moving and load bearing cracks. Cracked substrates with cracks wider than 0.01 inch must be pressure injected with epoxy prior to FRP installation. For concrete substrates, refer to ACI 224.1R. Smaller cracks exposed to aggressive environments may require resin injection or sealing to prevent corrosion of existing steel reinforcement. Crack-width criteria for various exposure conditions are given in ACI 224R.

D. Areas where loose or deteriorated concrete have been removed shall be filled with a repair system as necessary to restore the original shape of the element and prepare the surface profile for the composite strengthening system.
   1. The repair system shall consist of:
      a. Single component high performance mortar repair product, or.
      b. A combination of: steel reinforcing primer, bonding agent (if required by the engineer of record), and high performance mortar repair product as noted in the construction drawings depending on the size and condition of the void to be filled.
   2. The contractor shall follow the manufacturer's printed surface preparation and installation instructions of each component of the repair system to be used.

3.2 SURFACE PREPARATION

A. Surfaces to receive FRP shall be clean and sound at time of application. All dust, laitance, grease, curing compounds, and other foreign materials that may hinder the bond must be removed before installation.

B. All concrete surfaces shall be dry and free of surface moisture. If surface moisture is of concern, the surfaces shall be tested by the contractor to evaluate moisture transmission in accordance with ASTM D4263.

C. Existing concave and convex surfaces must be filled/transitioned with epoxy paste. To repair voids, CSS-EP or CSS-ES thickened with fumed silica may be extended with FX-702 at no more than a 1:1 ratio by volume.

D. The concrete shall be abrasively prepared to achieve an ICRI CSP 3 profile by means of grinding, sand blasting, shot blasting, or pressure washing.

E. Any corners to be wrapped around shall be rounded to a ¾ inch minimum radius using a grinder or epoxy paste.

3.3 SURFACE MOUNTED APPLICATION

A. Verify ambient and concrete surface temperatures are between 45°F and 95°F.

B. Apply one coat of epoxy primer using a nap roller when using fabrics.

C. Apply epoxy paste where minor surface defects are present.

D. Allow the primer and/or paste to become tacky to the touch before applying the saturated fabric.

E. When manually saturating fabric, precut sheets to required length using heavy duty shears before saturating with hand rollers. If mechanically saturating fabric with rollers, cut sheets using heavy duty shears either before or after they go through the epoxy bath. In both cases, ensure full fabric saturation is achieved.

F. Apply the saturated fabric to the installation surface and remove entrapped air using hand pressure, rollers, or trowels.

G. Apply additional layers as necessary to meet the project requirements, ensuring each layer is firmly adhered to the previous layer.

H. Feather all fabric seams/edges with epoxy paste.

I. Confirm that intimate contact between composite system and substrate will be maintained throughout the curing process.

J. Apply finish coating after full epoxy cure, lightly sanding epoxy surfaces before installation.

K. When metal penetrations are made through carbon FRP or metal is to be placed against carbon FRP, a barrier of glass FRP, epoxy paste, or air shall be provided between the carbon FRP and metal to ensure no electrical connection between the two materials.

3.4 QUALITY CONTROL

A. Field Monitoring.
   1. The work performed in the preceding sections of Part 3 of this specification will be field monitored by the Owner’s Special Inspection Agency and will be paid for by the owner. The surface preparation shall be checked immediately before application of the composite system materials. Periodic inspection shall be provided during the application process.
   2. The special inspector must complete the Manufacturer’s installation training procedure and submit certification of successful completion.
   3. The special inspector must submit a letter indicating full understanding of the all the requirements of ICC ES (ACI 78), signed and sealed by a professional engineer in the State of North Carolina.
   4. The special inspector shall create daily reports that document the following:
      a. Date and time of installation.
      b. Ambient temperature, relative humidity, and weather conditions.
      c. Substrate surface temperature and dryness.
      d. Surface preparation method and ICRI concrete surface profile.
      e. Surface cleanliness description.
      f. Fabric batch numbers.

g. Epoxy batch numbers, mix ratios, and mixing times.
h. Application locations.
i. Conformance with installation procedures.
j. Location and size of any delaminations/voids identified or repaired.

5. For fabric systems, the contractor shall create a minimum of two material sample sets daily. Each set will consist of two 12 in. by 12 in. panels made of two layers of saturated fabric and the sets shall be taken at different times during the working shift so that it is representative of maximum variances in material/site conditions. Prepare samples on a flat, level surface covered with heavy-duty vinyl (or similar). Prime vinyl with epoxy saturant, place saturated layers, and apply a top coat of epoxy saturant. Samples shall be cured at the site under the same environmental conditions as the production work they represent and must be marked with sample date, time, epoxy/fabric batch numbers, and installation locations.

B. Field Testing.
1. Adhesion Test.
a. Pull-off tests shall be conducted in accordance with ASTM D7522 and/or ASTM D4541 and performed on flat surfaces. 3 tests shall be executed on each type of substrate or surface preparation method used, with a minimum of 3 tests per 1000 square feet of surface area covered. Testing shall be done on an area adjacent to strengthening locations with substrate, surface preparation, and orientation (i.e. overhead, vertical, etc.) that are representative of that being strengthened. Before pull-off tests are performed, the composite system shall be allowed to reach full cure.
b. Adhesion strengths shall be in excess of 200 psi.
2. Concrete Repair.
a. The cured repair material shall be sounded for delaminations.
b. An in-situ direct tensile pull-off bond test of the cured repair material shall be performed per ICRI Technical Guideline No. 210.3R to evaluate the bond of the repair material to the substrate (if required by the engineer of record).

C. Lab Testing.
1. Tension Tests.
a. General.
b. 1). Lab tension tests are only required when structural performance criteria is specified.
c. 2). Tension tests shall be performed to verify the tensile strength, strain, and modulus of the composite strengthening system based on the nominal layer thickness reported on the manufacturer’s data sheet and used in the design calculations.
d. 3). The composite tensile properties used in the design calculations must be lower than the average of the test results unless calculations are performed with the reported average tensile properties show that the strengthening requirements are satisfied.
e. b. Fabric Systems.
f. 1). One panel from a minimum of 15% of all sample sets shall be selected for tension testing performed in accordance with ASTM D7565 and/or ASTM D3039.

D. Defects.
   1. Small delaminations less than 2 square inches are acceptable so long as the delaminated area is less than 5% of the total laminate area and there are no more than 10 such delaminations per 10 square feet.
   2. Large delaminations greater than 25 square inches shall be locally cut away and a new material shall be applied with an equivalent number of layers and sufficient development length overlaps.
   3. Delaminations between 2 square inches and 25 square inches shall be injected with epoxy or replaced, depending on the size, number of delaminations, and locations.

E. Remedial Measures.
   1. If the composite tensile properties used in the design calculations are higher than the average of the laboratory test results, design calculations shall be resubmitted, showing that the target design performance has been achieved. If this is not the case, additional layers shall be applied until the target design performance is reached.

END OF SECTION 030130

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:
   1. Cast-in-place concrete, including concrete materials, mixture design, placement procedures, and finishes.

B. Related Requirements:
   1. Section 034500 “Architectural Concrete” for general building applications of specially finished formed concrete.
   2. Section 312000 “Earth Moving” for drainage fill under slabs-on-ground.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

B. Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
      a. Contractor’s superintendent.
      b. Independent testing agency responsible for concrete design mixtures.
      c. Ready-mix concrete manufacturer.
      d. Concrete Subcontractor.
      e. Special concrete finish Subcontractor.
   2. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
      a. Special inspection and testing and inspecting agency procedures for field quality control.
      b. Construction joints, control joints, isolation joints, and joint-filler strips.
      c. Vapor-retarder installation.

d. Anchor rod and anchorage device installation tolerances.
e. Cold and hot weather concreting procedures.
f. Concrete finishes and finishing.
g. Curing procedures.
h. Forms and form-removal limitations.
i. Methods for achieving specified floor and slab flatness and levelness.
j. Floor and slab flatness and levelness measurements.
k. Concrete repair procedures.
l. Concrete protection.
m. Initial curing of test cylinders (ASTM C31/C31M.).
n. Protection of test cylinders.

1.5 ACTION SUBMITTALS

A. Product Data: For each of the following.
1. Portland cement.
2. Fly ash.
3. Aggregates.
4. Admixtures:
a. Include limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.
5. Vapor retarder.
6. Curing Materials.
7. Joint fillers.
8. Repair materials.

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
1. Indicate amounts of mixing water to be withheld for later addition at Project site.

C. Steel Reinforcement Shop Drawings: Prepare shop drawings in accordance with ACI 315. Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
1. Include special reinforcement required for openings through concrete structures and dimensioned opening locations. Include applicable dimensions, sections, elevations, and details required to complete installation and coordination of the details, and typical details. Plan shall be drawn at a scale of no less than 1/8” per foot.

D. Construction and Control Joint Layout: Indicate proposed construction joints required to construct the structure as well as wall and slab control joint locations.
1. Location of construction and control joints is subject to approval of the Architect.

1.6 INFORMATION SUBMITTALS

A. Qualification Data: For Installer and Ready Mix Manufacturer.

B. Welding Certificates.

C. Material Certificates: For each of the following, signed by manufacturers:
1. Cementitious materials.
2. Coarse and Fine Aggregates.
3. Admixtures.
4. Form materials and form-release agents.
5. Steel reinforcement and accessories.
6. Waterstops.
7. Curing compounds.
8. Floor and slab treatments.
9. Bonding agents.
10. Adhesives.
11. Vapor retarders.
12. Semirigid joint filler.
13. Joint-filler strips.
14. Repair materials.

D. Material Test Reports: For the following, from a qualified testing agency indicating conformance with the material specification:
1. Aggregates: Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
2. Cementitious materials.
3. Steel Reinforcement.

E. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.

F. Minutes of preinstallation conference.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
1. Manufacturer certified according to NRMCA’s “Certification of Ready Mixed Concrete Production Facilities.”.

C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
   1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
   2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.

D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4.

1.8 DELIVERY,STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

1.9 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
   1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 306.1.
   2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
   3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

B. Hot-Weather Placement: Comply with ACI 305.1 and as follows:
   1. Maintain concrete temperature below 95 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor’s option.
   2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.
      a. Maximum temperature of forms, reinforcement, anchor bolts, and other embedded items shall not exceed 120 deg F.

PART 2 PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

B. 1. ACI 301.

C. 2. ACI 117.

D. 3. ACI 315.

E. 4. CRSI “Manual of Standard Practice.”.

F. 5. ACI 318.

2.2 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
   1. Plywood, metal, or other approved panel materials.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

D. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.
   1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

E. Form Ties: Factory-fabricated, removable, or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
   1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
   2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.
   3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.3 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706, deformed.

C. Deformed-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, flat sheet.

D. Deformed-Steel Wire: ASTM A 1064 / A 1064M.

E. Deformed Bar Anchors (DBAs): ASTM A1064, plain, Type C, 70,000 psi yield strength.

2.4 REINFORCEMENT ACCESSORIES

A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
   1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.

2.5 CONCRETE MATERIALS

A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer’s plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

B. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
   1. Portland Cement: ASTM C 150, Type I/II, gray.
   2. Fly Ash: ASTM C 618, Class F.

C. Normal-Weight Aggregates: ASTM C 33, Class 3M coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.
   1. Maximum Coarse-Aggregate Size: 1-1/2 inches nominal.
   2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

D. Water: ASTM C 94/C 94M and potable.

E. Air-Entraining Admixture: ASTM C 260.

F. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
   1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
   2. Retarding Admixture: ASTM C 494/C 494M, Type B.
   3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
   4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
   5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
   6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.6 WATERSTOPS

A. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.
   1. Waterstops applied where only 1 curtain of vertical reinforcing exists shall be certified by the manufacturer as acceptable for such applications.

2.7 VAPOR RETARDERS

A. Sheet Vapor Retarder: ASTM E 1745, Class A, except with maximum water-vapor permeance of 0.01 and minimum 15 mils thickness. Include manufacturer's recommended adhesive or pressure-sensitive tape.

2.8 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.
   1. Apply to concrete surfaces to receive polished concrete finish.

2.9 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

E. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

2.10 2.10 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

B. Bonding Agent: ASTM C 1059/C 1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

C. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of

grade to suit requirements, and as follows:

D. 1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.11 2.11 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
   1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
   2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
   3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
   4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109/C 109M.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.
   1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
   2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
   3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
   4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109/C 109M.

2.12 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
   1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

C. 1. Fly Ash: 25 percent.

D. Limit water-soluble, chloride-ion content in hardened concrete as follows:

E. 0.30 percentage by weight of cement.

F. Admixtures: Use admixtures according to manufacturer's written instructions.

G. Use water-reducing, high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.

H. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

I. Use water-reducing admixture in pumped concrete and concrete with a w/c ratio below 0.50.

2.13 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Footings: Normal-weight concrete.
   1. Minimum Compressive Strength: 3,000 psi at 28 days.
   2. Maximum W/C Ratio: 0.50.
   3. Slump Limit: 4 inches, plus or minus 1 inch or 8 inches (maximum) for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture at Project site.
   4. Air Content: 1.5 percent, plus or minus 1.5 percent.
   5. Maximum Aggregate Size : 1 inch.

B. Stair Wing Walls: Normal-weight concrete.
   1. Minimum Compressive Strength: 4,000 psi at 28 days.
   2. Maximum W/C Ratio: 0.45.
   3. Slump Limit: 4 inches, plus or minus 1 inch or 8 inches (maximum) for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture at Project site.
   4. Air Content: 5 percent, plus or minus 1.5 percent at point of final placement, for site walls exposed to weather in the final condition. No entrained air required for building foundation walls.
   5. Maximum Aggregate Size : 3/4 inch.

C. Interior Slabs-on-Grade: Normal-weight concrete.
   1. Minimum Compressive Strength: 3,500 psi at 28 days.
   2. Maximum W/C Ratio: 0.45.
   3. Slump Limit: 4 inches, plus or minus 1 inch or 8 inches (maximum) for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture at Project site.
   4. Air Content: 1.5 percent, plus or minus 1.5 percent at point of final placement. Do not allow air content of trowel-finished floors to exceed 3 percent.
   5. Maximum Aggregate Size : 3/4 inch.

D. Exterior Slabs-on Grade: Normal-weight concrete.
   1. Minimum Compressive Strength: 3,500 psi at 28 days.
   2. Maximum W/C Ratio: 0.45.
   3. Slump Limit: 4 inches, plus or minus 1 inch or 8 inches (maximum) for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture at Project site.
   4. Air Content: 5 percent, plus or minus 1.5 percent at point of final placement.
   5. Maximum Aggregate Size : 3/4 inch.

E. Interior Concrete Slabs Topping: Lightweight concrete.
   1. Minimum Compressive Strength: 4,000 psi at 28 days.
   2. Calculated Equilibrium Unit Weight: 113 lb/cu. ft., plus or minus 3 lb/cu. ft. as determined by ASTM C 567.
   3. Slump Limit: 4 inches, plus or minus 1 inch or 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture.
   4. Air Content: 5.5 percent, plus or minus 1.5 percent at point of final placement. Do not allow air content of trowel-finished floors to exceed 3 percent.
   5. Aggregate Size: Normal Weight, 3/4 inch.

2.14 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.15 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.
   1. Limit concrete mixing and delivery time to 90 minutes.
   2. Concrete Temperature: 50 deg F minimum, 95 deg F maximum, at point of placement.

PART 3 EXECUTION

3.1 FORMWORK INSTALLATION

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
   1. Class A, 1/8 inch for smooth-formed finished exposed surfaces.
   2. Class B, 1/4 inch for rough-formed finished non-exposed surfaces.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Construct forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
   1. Install keyways and the like for easy removal.
   2. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed

strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Chamfer exterior corners and edges of permanently exposed concrete.

I. Form openings, chases, offsets, keyways, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEMS INSTALLATION

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.

3.3 REMOVING AND REUSING FORMS

A. General: Formwork for sides of grade beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 48 hours after placing concrete. Concrete must be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material are not acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.4 VAPOR-RETARDER INSTALLATION

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.
   1. Lap joints 6 inches and seal with manufacturer's recommended tape.
   2. Extend vapor retarder 2 feet beyond core and shell slab-on-grade extents for future connection with vapor barrier from tenant upfit.
   3. Protect exposed portions of vapor retarder until adjacent vapor retarder and slab from tenant upfit have been installed.

3.5 STEEL REINFORCEMENT INSTALLATION

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
   1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded-wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.6 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
   1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated.
   2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
   3. Locate joints for grade beams and slabs, as indicated.
   4. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
   5. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
   1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks. Cut joints the same day as concrete placement and within 12 hours.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
   1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
   2. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.7 WATERSTOPS

A. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding, mechanically fastening, and firmly pressing into place. Install in longest lengths practicable.

3.8 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.

B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
   1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
   1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
   2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
   3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded

items without causing mixture constituents to segregate.

D. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
   1. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
   2. Maintain reinforcement in position on chairs during concrete placement.
   3. Screed slab surfaces with a straightedge and strike off to correct elevations.
   4. Slope surfaces uniformly to drains where required.
   5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

3.9 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
   1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
   1. Apply to concrete surfaces exposed to public view.

C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

D. Rubbed Finish: Apply the following to smooth-formed-finished as-cast concrete:
   1. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix 1 part Portland cement to 1-1/2 parts fine sand with a 1:1 mixture of bonding admixture and water. Add white Portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.

3.10 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.
   1. Apply scratch finish to surfaces to receive mortar setting beds for bonded cementitious floor finishes.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
   1. Apply float finish to surfaces to receive trowel finish.
   2. Apply to slabs-on-grade.
   3. Apply to suspended concrete slabs.

D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
   1. Apply a trowel finish to non-air entrained surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile.
   2. Finish surfaces to the following tolerances, according to ASTM E 1155, for a randomly trafficked floor surface:
      a. Specified overall values of flatness, F(F) 25; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and of levelness, F(L) 15, unless otherwise noted.
      b. Specified overall values of flatness, F(F) 40; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for slab-on-grade.
      c. Specified overall values of flatness, F(F) 30; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 15; for suspended slabs.

E. Fine-Broom Finish: Apply a first trowel or float finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. While concrete is still plastic, slightly scarify surface with a fine broom.
   1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.
   1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

3.11 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to

complete the Work.

B. Equipment Bases and Foundations:
   1. Coordinate sizes and locations of concrete bases with actual equipment provided.
   2. Construct concrete bases to height indicated, and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated or required by equipment manufacturer.
   3. Minimum Compressive Strength: 3000 psi at 28 days (Normal Weight).
   4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 12-inch centers around the full perimeter of concrete base.
   5. Prior to pouring concrete, place, and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   6. Cast anchor-bolt insert into bases. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel finish concrete surfaces. Provide 3000 psi compressive strength normal-weight concrete.

3.12 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 305.1 for hot-weather protection during curing. For concrete specified to be receive polished finish the outdoor air temperature during the curing period must be limited to 80 deg F.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
   1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
      a. Water.
      b. Continuous water-fog spray.
      c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
   2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven

days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape:

a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments or polished finish.
c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies does not interfere with bonding of floor covering used on Project.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
   a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project.
   b. Use of curing compounds to cure concrete surfaces to receive penetrating liquid floor treatments or polished finished is not permitted.
4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.13 LIQUID FLOOR TREATMENT APPLICATION

A. Penetrating Liquid Floor Treatment: Prepare, apply and finish penetrating liquid floor treatment according to manufacturer’s written instructions.
   1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
   2. Do not apply to concrete until cured for minimum amount of time stipulated in manufacturer’s written instructions.
   3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.

3.14 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Repair technique for surfaces exposed to view in the final condition shall be tested on a mockup or surface to be concealed later, before repairing surfaces.
   1. Repair test shall be approved by the Architect prior to repairing surfaces.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
   1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
   2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
   3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
   1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
   2. After concrete has cured at least 14 days, correct high areas by grinding.
   3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
   4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
   5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
   6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
   7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.15 SPECIAL INSPECTIONS

A. Special Inspections and tests shall be performed by the Special Inspector or Special Inspection Agency.

B. Verification and inspection of concrete construction shall be in accordance with the Statement of Special Inspections, Section 1705.3 of the 2018 North Carolina State Building Code and as follows:
   1. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
      a. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
         1) (1) When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
      b. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
      c. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173/C 173M, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
      d. Concrete Temperature: ASTM C 1064/C 1064M; one test at point of delivery for each truck and one test at point of placement for each 25 cu. yd. placed.
      e. Unit Weight: ASTM C 567, fresh unit weight of structural normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
      f. Compression Test Specimens: ASTM C 31/C 31M.
         1) (1) Cast and laboratory cure five 4x8 standard cylinder specimens for each composite sample.
      g. Compressive-Strength Tests: ASTM C 39/C 39M; test one laboratory-cured specimen at 7 days and three laboratory-cured specimens at 28 days. Maintain one specimen in reserve for later testing, if required.
         1) (1) A compressive-strength test shall be the average compressive strength from a set of three specimens obtained from same composite sample and tested at age indicated.
         2) (2) Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
      h. Measure floor and slab flatness and levelness according to ASTM E 1155 within 48 hours of finishing.

i. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

1) j. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

j. k. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strength, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Architect.

2. Inspections: Perform inspections of the work to verify compliance with the requirements of the contract documents, including the following:
   a. Steel reinforcement placement.
   b. Steel reinforcement welding.
   c. Headed bolts and studs.
   d. Verification of use of required design mixture.
   e. Concrete placement, including conveying and depositing.
   f. Curing procedures and maintenance of curing temperature.
   g. Verification of concrete strength.
   h. Concrete batch plant and review procedures for maintaining proper mix proportions and proper mix techniques.
   i. Concrete delivery tickets at time of delivery to assure conformance to ACI 318.

C. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

D. Additional testing and inspecting, at Contractor’s expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.16 PROTECTION OF LIQUID FLOOR TREATMENTS

A. Protect liquid floor treatment from damage and wear during the remainder of constriction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION 033000

SECTION 033511 - SEALED CONCRETE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Surface treatments for concrete floors and slabs where marked as "Sealed Concrete".

1.2 RELATED REQUIREMENTS

A. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions.

B. Section 033000 - Cast-in-Place Concrete: Curing compounds that also function as sealers.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordinate the work with concrete floor placement and concrete floor curing.

1.4 SUBMITTALS

A. Product Data: Manufacturer's published data, including information on compatibility of products and limitations with curing compounds.

B. Maintenance Data: Provide data on maintenance and renewal of applied finishes.

C. Warranty Documentation: Manufacturer warranty; ensure that forms have been completed in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

A. For slabs indicated to receive concrete polishing system, do not proceed with concrete polishing unless manufacturer's representative and specialized equipment is present for every day of placement.

1.6 MOCK-UP

A. For surface treatments, construct mock-up area under conditions similar to those that will exist during application, with surface treatments applied.

B. Mock-Up Size: 10 feet square.

C. Locate where directed.

D. Mock-up may remain as part of the work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's sealed packaging, including application instructions.

1.8 FIELD CONDITIONS

A. Do not seal floors until interior conditions meet manufacturer's requirements.

1.9 WARRANTY

A. Correct defective work within a two-year period commencing on the Date of Substantial Completion.

B. Finish Warranty: Provide five-year manufacturer warranty against excessive degradation of finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS

2.1 CONCRETE FLOOR FINISH APPLICATIONS

A. Unless otherwise indicated, all concrete floors indicated on the Finish Schedule to have "Sealed Concrete" are to be finished using penetrating sealer.

B. Penetrating Sealer: Transparent, non-yellowing, water- or solvent-based coating meeting VOC requirements specified in Section 016116.
   1. Composition: Silane-siloxane mixture.
   2. Acceptable Manufacturers:
      a. Clemons Concrete Coatings: www.clemonsconcretecoatings.com.
      b. Concrete Sealers USA: www.concretesealersusa.com.
      c. TK Products Construction Coatings: www.surecretedesign.com.
      d. PROSOCO: www.prosoco.com.
      e. W.R. Meadows: ww.wrmeadows.com.

2.2 SURFACE TREATMENTS

A. Finish surface of sealer to create a broomed appearance.

B. Color: As selected by Architect.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that floor surfaces are acceptable to receive the work of this section.

B. Verify that flaws in concrete have been patched and joints filled with methods and materials suitable for further finishes.

3.2 GENERAL

A. Apply materials in accordance with manufacturer's instructions and written specifications.

3.3 SURFACE TREATMENT APPLICATION

A. Verify that surface is free of previous coatings, sealers, curing compounds, water repellents, laitance, efflorescence, fats, oils, grease, wax, soluble salts, residues from cleaning agents, and other impediments to adhesion.

B. Verify that water vapor emission from concrete and relative humidity in concrete are within limits established by treatment manufacturer.

C. Protect adjacent non-treatment areas from drips, overflow, and overspray; immediately remove excess material.

D. Apply surface treatments in accordance with manufacturer's instructions, matching approved mock-ups for color, special effects, sealing and workmanship.

END OF SECTION 033511

SECTION 034500 - PRECAST ARCHITECTURAL CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Precast concrete steps.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" site-cast concrete requirements and for installing connection anchors in concrete.

1.2 DEFINITIONS

A. Design Reference Sample: Sample of approved architectural precast concrete color, finish, and texture, preapproved by Architect.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Precast architectural concrete unit design mixtures: Include compressive strength and water-absorption tests for each precast concrete mixture.
2. Mold materials.
3. Reinforcing materials.
4. Concrete materials.
5. Steel connection materials.
6. Stainless steel connection materials.
7. Accessories.
8. Grout materials.

B. Shop Drawings:

1. Detail fabrication and installation of architectural precast concrete units.
2. Indicate locations, plans, elevations, dimensions, shapes, and cross sections of each unit.
3. Indicate joints, reveals, drips, chamfers, and extent and location of each surface finish.

4. Indicate separate face and backup mixture locations and thicknesses.
5. Indicate type, size, and length of welded connections by AWS standard symbols. Detail loose and cast-in hardware and connections.
6. Indicate locations, tolerances, and details of anchorage devices to be embedded in or attached to structure or other construction.
7. Indicate locations, extent, and treatment of dry joints if two-stage casting is proposed.
8. Include plans and elevations showing unit locations, dimensions, erection sequences, and bracing plans for special conditions.
9. Indicate location of each architectural precast concrete unit by same identification mark placed on panel.
10. Indicate relationship of architectural precast concrete units to adjacent materials.
11. Indicate locations, type, dimensions, and details of facing units, including corner units, special shapes, joint treatment, and anchors.
12. Indicate multiple wythe connection details.
13. Coordinate and indicate openings and inserts required by other trades.
14. If design modifications are proposed to meet performance requirements and field conditions, submit design calculations and indicate modified areas on Shop Drawings. Do not adversely affect the appearance, durability, or strength of units.

C. Samples: Design reference samples for initial verification of design intent, for each type of finish indicated on exposed surfaces of architectural precast concrete units, in sets of three, representative of finish, color, and texture variations expected; approximately 12 by 12 by 2 inches.

1. When other faces of precast concrete unit are exposed, include Samples illustrating workmanship, color, and texture of backup concrete as well as facing concrete.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Provide locations, setting diagrams, templates, instructions, and directions, as required, for furnishing and installation of loose connection hardware and anchorage items to be embedded in or attached to other construction.

B. Material Test Reports: For each of the following items, for tests performed by qualified testing agency.

1. Aggregates.
2. Cementitious materials.
3. Reinforcing materials and prestressing tendons.
4. Admixtures.
5. Bearing pads.
6. Structural-steel shapes and hollow structural sections.

C. Preconstruction Test Reports: For mockups.

D. Qualification Statements: For fabricator and installer.

1.6 CLOSEOUT SUBMITTALS

A. General Contractor/Construction Manager Project Survey: Complete the survey form, providing feedback of the certified precast producer's performance in accordance with PCI's Architectural Certification Program. Submit to PCI as directed on form; provide a copy to Architect.

1.7 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm that assumes responsibility for engineering architectural precast concrete units to comply with performance requirements. This responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

1. Designated at time of bidding as a PCI-certified plant for Category AA or designated as an APA-certified plant for production of architectural precast concrete products.
2. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for types of units required, comply with PCI MNL 117 and PCI MNL 135.

B. Certified Installer Qualifications: A precast concrete erector qualified and designated by PCI's Certificate of Compliance to erect Category A (Architectural Systems) for nonload-bearing members.

C. Installer Qualifications: A precast concrete erector who has retained a "PCI-Certified Field Auditor" to conduct a field audit of a project in same category as this Project and who can produce an Erectors' Post-Audit Declaration.

D. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

E. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in state where Project is located and who is experienced in providing engineering services of the type indicated.

F. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:

1. AWS D1.4/D1.4M.

1.8 MOCKUPS

A. Build mockups to verify selections made under Sample submittals and for preconstruction testing.

1. After sample panel and range sample approval, build mockup for steps in size approximately 60 inches long by full height and depth, complete with anchors, connections, flashings, and joint fillers.

    a. Build preconstruction testing mockup at testing agency facility.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on mockups.

1. Provide test specimens and assemblies representative of proposed materials and construction.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver architectural precast concrete units in such quantities and at such times to limit unloading units temporarily on the ground or other rehandling.

B. Support units during shipment on nonstaining shock-absorbing material.

C. Store units with adequate dunnage and bracing, and protect units to prevent contact with soil, prevent staining, and prevent cracking, distortion, warping, or other physical damage.

D. Place stored units so identification marks are clearly visible, and units can be inspected.

E. Handle and transport units in a manner that avoids excessive stresses that cause cracking or damage.

F. Lift and support units only at designated points indicated on Shop Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design architectural precast concrete units including stone facing system.

B. Design Standards: Comply with ACI 318 and design recommendations of PCI MNL 120 applicable to types of architectural precast concrete units indicated.

C. Structural Performance: Provide architectural precast concrete units and connections capable of withstanding the following design loads within limits and under conditions indicated:

1. Seismic Loads.
2. Project-Specific Loads: TBD.
3. Thermal Movements: Provide for in-plane thermal movements resulting from annual ambient temperature changes of 80 deg F.

2.2 MOLD MATERIALS

A. Molds: Rigid, dimensionally stable, nonabsorptive material, warp and buckle free, that provides continuous and true precast concrete surfaces within fabrication tolerances indicated; nonreactive with concrete and suitable for producing required finishes.

B. Form Liners: Units of face design, texture, arrangement, and configuration to match those used for precast concrete design reference sample. Provide solid backing and supports to keep form liners in place during concrete placement.

C. Form-Release Agent: Commercially produced form-release agent that does not bond with, stain, or adversely affect precast concrete surfaces and does not impair subsequent surface or joint treatments of precast concrete.

D. Surface Retarder: Chemical-set retarder, capable of temporarily delaying final hardening of newly placed concrete mixture to depth of reveal specified.

2.3 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A706/A706M, deformed.

C. Steel Bar Mats: ASTM A184/A184M, fabricated from ASTM A615/A615M, Grade 60, deformed bars, assembled with clips.

D. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, fabricated from galvanized-steel wire into flat sheets.

E. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.

F. Supports: Suspend reinforcement from back of mold. Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcement in place may only be used if they are not visible in the finished face.

2.4 CONCRETE MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or Type III.

1. For surfaces exposed to view in finished structure, use gray and white cement, of same type, brand, and mill source.

a. Standard gray cement is acceptable for use where not exposed to view.

B. Supplementary Cementitious Materials:

1. Fly Ash: ASTM C618, Class C or F, with maximum loss on ignition of 3 percent.
2. Metakaolin: ASTM C618, Class N.
3. Silica Fume: ASTM C1240, with optional chemical and physical requirement.
4. Ground Granulated Blast-Furnace Slag: ASTM C989/C989M, Grade 100 or 120.
5. Blended Hydraulic Cement: ASTM C595/C595M, Type IP, portland-pozzolan.

C. Normal-Weight Aggregates: Except as modified by PCI MNL 117, ASTM C33/C33M, with coarse aggregates complying with Class 5S. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.

1. Face-Mixture-Coarse Aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining; to match approved finish sample.

a. Gradation: To match design reference sample.

2. Face-Mixture-Fine Aggregates: Selected, natural or manufactured sand compatible with coarse aggregate; to match approved finish sample.

D. Coloring Admixture: ASTM C979/C979M, synthetic or natural mineral-oxide pigments or colored water-reducing admixtures, temperature stable, and nonfading.

E. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 117 and ASTM C1602/C1602M.

F. Air-Entraining Admixture: ASTM C260/C260M, certified by manufacturer to be compatible with other required admixtures.

G. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture.

1. Water-Reducing Admixtures: ASTM C494/C494M, Type A.
2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
4. Water-Reducing and -Accelerating Admixture: ASTM C494/C494M, Type E.
5. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
6. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.
7. Plasticizing Admixture: ASTM C1017/C1017M, Type I.

8. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.
9. Corrosion-Inhibiting Admixture: ASTM C1582/C1582M.

2.5 ACCESSORIES

A. Bearing Pads: Provide one of the following for architectural precast concrete units as recommended by precast fabricator for application:

1. Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet, Type A durometer hardness of 50 to 70, ASTM D2240, minimum tensile strength 2250 psi, ASTM D412.
2. Random-Oriented-Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer; Type A durometer hardness of 70 to 90, ASTM D2240; capable of supporting a compressive stress of 3000 psi with no cracking, splitting, or delaminating in the internal portions of pad. Test one specimen for every 200 pads used in Project.
3. Cotton-Duck-Fabric-Reinforced Elastomeric Pads: Preformed, horizontally layered cotton-duck fabric bonded to an elastomer; Type A durometer hardness of 80 to 100, ASTM D2240; in compliance with AASHTO LRFDBDS, Division II, Section 18.10.2; or with MIL-C-882E.
4. Frictionless Pads: PTFE, glass-fiber reinforced, bonded to stainless or mild-steel plate, or random-oriented-fiber-reinforced elastomeric pads; of type required for in-service stress.
5. High-Density Plastic: Multimonomer, nonleaching, plastic strip.

B. Precast Accessories: Provide clips, hangers, high-density plastic or steel shims, and other accessories required to install architectural precast concrete units.

2.6 GROUT MATERIALS

A. Sand-Cement Grout: Portland cement, ASTM C150/C150M, Type I, and clean, natural sand, ASTM C144 or ASTM C404. Mix at ratio of 1 part cement to 2-1/2 to 3 parts sand, by volume, with minimum water required for placement and hydration. Water-soluble chloride ion content is to be less than 0.06 percent by weight of cement when tested in accordance with ASTM C1218/C1218M.

2.7 CONCRETE MIXTURES

A. Prepare design mixtures for each type of precast concrete required.

1. Use a single design mixture for units with more than one major face or edge exposed.
2. Where only one face of unit is exposed, use either a single design mixture or separate mixtures for face and backup.

B. Limit use of fly ash and ground granulated blast-furnace slag to 20 percent of portland cement by weight; limit metakaolin and silica fume to 10 percent of portland cement by weight.

C. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at architectural precast concrete fabricator's option.

D. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by ACI 318 or PCI MNL 117 when tested in accordance with ASTM C1218/C1218M.

E. Normal-Weight Concrete Mixtures: Proportion face and backup mixtures or full-depth mixtures, at fabricator's option by either laboratory trial batch or field test data methods in accordance with ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): 5000 psi (34.5 MPa) minimum.
2. Maximum Water-Cementitious Materials Ratio: 0.45.

F. Water Absorption: Six percent by weight or 14 percent by volume, tested in accordance with ASTM C642, except for boiling requirement.

G. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 117.

H. When included in design mixtures, add other admixtures to concrete mixtures in accordance with manufacturer's written instructions.

2.8 FABRICATION OF MOLDS

A. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete-placement operations and temperature changes and for prestressing and detensioning operations. Coat contact surfaces of molds with release agent before reinforcement is placed. Avoid contamination of reinforcement and prestressing tendons by release agent.

B. Maintain molds to provide completed architectural precast concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified.

1. Form joints are not permitted on faces exposed to view in the finished Project.
2. Edge and Corner Treatment: Uniformly radiused.

2.9 FABRICATION OF PRECAST ARCHITECTURAL CONCRETE

A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.

1. Weld-headed studs and deformed bar anchors used for anchorage in accordance with AWS D1.1/D1.1M and AWS C5.4.

B. Furnish loose hardware items, including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing architectural precast concrete units to supporting and adjacent construction.

C. Cast-in reglets, slots, holes, and other accessories in architectural precast concrete units, as indicated on the Drawings.

D. Reinforcement: Comply with recommendations in PCI MNL 117 for fabricating, placing, and supporting reinforcement.

1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete. When damage to epoxy-coated reinforcing exceeds limits specified in ASTM A775/A775M, repair with patching material compatible with coating material and epoxy coat bar ends after cutting.
2. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.
3. Place reinforcing steel and prestressing strands to maintain at least 3/4-inch minimum concrete cover. Increase cover requirements for reinforcing steel to 1-1/2 inches when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.
4. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh spacing and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Reinforce architectural precast concrete units to resist handling, transportation, and erection stresses and specified in-place loads.

F. Prestress tendons for architectural precast concrete units by either pretensioning or post-tensioning methods. Comply with PCI MNL 117.

1. Delay detensioning or post-tensioning of precast, prestressed architectural concrete units until concrete has reached its indicated minimum design release compressive strength as established by test cylinders cured under same conditions as concrete unit.
2. Detension pretensioned tendons either by gradually releasing tensioning jacks or by heat-cutting tendons, using a sequence and pattern to prevent shock or unbalanced loading.
3. If concrete has been heat cured, detension while concrete is still warm and moist to avoid dimensional changes that may cause cracking or undesirable stresses.
4. Protect strand ends and anchorages with bituminous, zinc-rich, or epoxy paint to avoid corrosion and possible rust spots.

G. Comply with requirements in PCI MNL 117 and requirements in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.

H. Place face mixture to a minimum thickness after consolidation of the greater of 1 inch or 1.5 times the maximum aggregate size, but not less than the minimum reinforcing cover specified.

I. Place concrete in a continuous operation to prevent cold joints or planes of weakness from forming in precast concrete units.

1. Place backup concrete mixture to ensure bond with face-mixture concrete.

J. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air voids on surfaces. Use equipment and procedures complying with PCI MNL 117.

1. Place self-consolidating concrete without vibration in accordance with PCI TR-6. Ensure adequate bond between face and backup concrete, if used.

K. Comply with PCI MNL 117 for hot- and cold-weather concrete placement.

L. Identify pickup points of architectural precast concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each architectural precast concrete unit on a surface that does not show in finished structure.

M. Cure concrete, in accordance with PCI MNL 117, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.

N. Discard and replace architectural precast concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs comply with requirements in PCI MNL 117 and Architect's approval.

2.10 FABRICATION TOLERANCES

A. Fabricate architectural precast concrete units to shapes, lines, and dimensions indicated so each finished unit complies with PCI MNL 117 product tolerances as well as position tolerances for cast-in items.

B. Position Tolerances: For cast-in items measured from datum line location, as indicated on Shop Drawings.

1. Weld Plates: Plus or minus 1 inch.
2. Tipping and Flushness of Plates: Plus or minus 1/4 inch.
3. Dimensions of Architectural Features and Rustications: Plus or minus 1/8 inch.
4. Inserts: Plus or minus 1/2 inch.

5. Handling Devices: Plus or minus 3 inches.
6. Reinforcing Steel and Welded-Wire Reinforcement: Plus or minus 1/4 inch where position has structural implications or affects concrete cover; otherwise, plus or minus 1/2 inch.
7. Reinforcing Steel Extending out of Member: Plus or minus 1/2 inch.
8. Prestressing Reinforcement: Plus or minus 1/4 inch, perpendicular to panel; plus or minus 1 inch, parallel to panel.
9. Location of Rustication Joints: Plus or minus 1/8 inch.
10. Electrical Outlets, Hose Bibs: Plus or minus 1/2 inch.
11. Location of Bearing Surface from End of Member: Plus or minus 1/4 inch.
12. Position of Sleeve: Plus or minus 1/2 inch.

2.11 FINISHES

A. Exposed faces to be free of joint marks, grain, and other obvious defects. Corners, including false joints to be uniform, straight, and sharp. Finish exposed-face surfaces of architectural precast concrete units to match approved mockups and as follows:

1. Design Reference Sample: Fabricator TBD.
2. PCI's "Architectural Precast Concrete - Color and Texture Selection Guide," of plate numbers indicated.

B. Finish exposed top surfaces of architectural precast concrete units to match face-surface finish with smooth, steel-trowel finish.

C. Finish unexposed surfaces of architectural precast concrete units with as-cast finish.

2.12 SOURCE QUALITY CONTROL

A. Quality-Control Testing: Test and inspect precast concrete in accordance with PCI MNL 117 requirements. If using self-consolidating concrete, also test and inspect in accordance with PCI TR-6, ASTM C1610/C1610M, ASTM C1611/C1611M, ASTM C1621/C1621M, and ASTM C1712.

B. Owner will employ an independent testing agency to evaluate architectural precast concrete fabricator's quality-control and testing methods.

1. Allow Owner's testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with Owner's testing agency and provide samples of materials and concrete mixtures as may be requested for additional testing and evaluation.

C. Strength of precast concrete units is considered deficient if units fail to comply with ACI 318 requirements for concrete strength.

D. Testing: Fabricator will employ an independent testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength in accordance with ASTM C42/C42M and ACI 318.

1. A minimum of three representative cores to be taken from units of suspect strength, from locations directed by Architect.
2. Test cores in an air-dry condition.
3. Strength of concrete for each series of three cores is considered satisfactory if average compressive strength is equal to at least 85 percent of 28-day design compressive strength and no single core is less than 75 percent of 28-day design compressive strength.
4. Report test results in writing on same day that tests are performed, with copies to Architect, Contractor, and precast concrete fabricator. Test reports include the following:

    a. Project identification name and number.
    b. Date when tests were performed.
    c. Name of precast concrete fabricator.
    d. Name of concrete testing agency.
    e. Identification letter, name, and type of precast concrete unit(s) represented by core tests; design compressive strength; type of break; compressive strength at breaks, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.

E. Patching: If core test results are satisfactory and precast concrete units comply with requirements, clean and dampen core holes and solidly fill with precast concrete mixture that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.

F. Defective Units: Discard and replace recast architectural concrete units that do not comply with acceptability requirements in PCI MNL 117, including concrete strength, manufacturing tolerances, and color and texture range. Chipped, spalled, or cracked units may be repaired, subject to Architect's approval. Architect reserves the right to reject precast units that do not match approved samples, sample panels, and mockups. Replace unacceptable units with precast concrete units that comply with requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, bearing surface tolerances, and other conditions affecting performance of the Work.

B. Do not install precast concrete units until supporting cast-in-place concrete has attained minimum allowable design compressive strength and supporting steel or other structure is structurally ready to receive loads from precast concrete units.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF PRECAST ARCHITECTURAL CONCRETE UNITS

A. Install clips, hangers, bearing pads, and other accessories required for connecting architectural precast concrete units to supporting members and backup materials.

B. Erect architectural precast concrete level, plumb, and square within specified allowable tolerances. Provide temporary supports and bracing as required to maintain position, stability, and alignment of units until permanent connections are completed.

1. Install temporary steel or plastic spacing shims as precast concrete units are being erected. Tack weld steel shims to each other to prevent shims from separating.
2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
3. Remove projecting lifting devices and grout fill voids within recessed lifting devices flush with surface of adjacent precast surfaces when recess is exposed.
4. Unless otherwise indicated, maintain uniform joint widths of 3/4 inch.

C. Connect architectural precast concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.

1. Do not permit connections to disrupt continuity of roof flashing.

D. At bolted connections, use lock washers, tack welding, or other approved means to prevent loosening of nuts after final adjustment.

1. Where slotted connections are used, verify bolt position and tightness. For sliding connections, properly secure bolt but allow bolt to move within connection slot.
2. For slip-critical connections, use one of the following methods to assure proper bolt pretension:

    a. Turn-of-Nut: In accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
    b. Calibrated Wrench: In accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
    c. Twist-off Tension Control Bolt: ASTM F3125/F3125M, Grade 1852.
    d. Direct-Tension Control Bolt: ASTM F3125/F3125M, Grade 1852.

3. For slip-critical connections, use method and inspection procedure approved by Architect and coordinated with inspection agency.

E. Grouting or Dry Packing Connections and Joints: Grout connections where required or indicated. Retain flowable grout in place until hard enough to support itself. Alternatively, pack spaces with stiff dry pack grout material, tamping until voids are completely filled. Place grout and finish smooth, level, and plumb with adjacent concrete surfaces. Promptly remove grout material from exposed surfaces before it affects finishes or hardens. Keep grouted joints damp for not less than 24 hours after initial set.

3.3 ERECTION TOLERANCES

A. Erect architectural precast concrete units level, plumb, square, and in alignment, without exceeding the following noncumulative erection tolerances:

1. Plan Location from Building Grid Datum: Plus or minus 1/2 inch.
2. Plan Location from Centerline of Steel: Plus or minus 1/2 inch.
3. Top Elevation from Nominal Top Elevation: As follows:

    a. Exposed Individual Panel: Plus or minus 1/4 inch.
    b. Nonexposed Individual Panel: Plus or minus 1/2 inch.

4. Support Elevation from Nominal Support Elevation: As follows:

    a. Maximum Low: 1/2 inch.
    b. Maximum High: 1/4 inch.

5. Maximum Plumb Variation over the Lesser of Height of Structure or 100 ft. (30 m): 1 inch.
6. Plumb in Any 10 ft. (3 m) of Unit Height: 1/4 inch**.**
7. Maximum Jog in Alignment of Matching Edges: 1/4 inch.

    a. Exposed Panel Relative to Adjacent Panel: 1/4 inch.
    b. Nonexposed Panel Relative to Adjacent Panel: 1/2 inch.

8. Joint Width (Governs over Joint Taper): Plus or minus 1/4 inch for joints over 10 ft. in length.
9. Maximum Joint Taper: Plus or minus 1/4 inch for joints over 10 ft.
10. Maximum Jog in Alignment of Matching Faces: 1/4 inch.
11. Differential Bowing or Camber, as Erected, between Adjacent Members of Same Design: 1/4 inch.
12. Opening Height between Spandrels: Plus or minus 1/4 inch.

3.4 REPAIR

A. Repair architectural precast concrete units if permitted by Landscape Architect. Landscape Architect reserves the right to reject repaired units that do not comply with requirements.

B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 ft.

C. Prepare and repair damaged galvanized coatings with galvanizing repair paint in accordance with ASTM A780/A780M.

D. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.

E. Remove and replace damaged architectural precast concrete units when repairs do not comply with requirements.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Erection of loadbearing precast concrete members.
2. Visually inspect field welds and test in accordance with ASTM E165/E165M or to ASTM E709 and ASTM E1444/E1444M.
3. High-strength bolted connections are subject to inspections.

C. Prepare test and inspection reports.

D. Repair or remove and replace work where tests and inspections indicate that it does not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, to be performed to determine compliance of replaced or additional work with specified requirements.

3.6 CLEANING

A. Clean surfaces of precast concrete units exposed to view.

B. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.

C. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.

1. Perform cleaning procedures, if necessary, in accordance with precast concrete fabricator's recommendations. Protect other work from staining or damage due to cleaning operations.
2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION 034500

SECTION 034500 - PRECAST ARCHITECTURAL CONCRETE

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Architectural precast concrete units.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Design Mixtures: For each precast concrete mixture. Include compressive strength and water-absorption tests.

C. Shop Drawings: Detail fabrication and installation of architectural precast concrete units. Indicate locations, dimensions, and shapes of each unit. Indicate joints, reveals, and extent and location of each surface finish.

D. Samples: For each type of finish indicated on exposed surfaces of architectural precast concrete units, in sets of 3, illustrating full range of finish, color, and texture variations expected; approximately 12 by 12 by 2 inches (300 by 300 by 50 mm).

E. Material Certificates: For the following items, signed by manufacturers:
   1. Cementitious materials.
   2. Reinforcing materials and prestressing tendons.
   3. Admixtures.
   4. Structural-steel shapes and hollow structural sections.
   5. Stone anchors.

1.4 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm that assumes responsibility for engineering architectural precast concrete units to comply with performance requirements. This responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

B. Design Standards: Comply with ACI 318 (ACI 318M) and design recommendations of

PCI MNL 120, "PCI Design Handbook - Precast and Prestressed Concrete," applicable to types of architectural precast concrete units indicated.

C. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for types of units required, comply with PCI MNL 117, "Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver architectural precast concrete units in such quantities and at such times to limit unloading units temporarily on the ground.

B. Support units during shipment on non-staining shock-absorbing material.

C. Store units with adequate dunnage and bracing and protect units to prevent contact with soil, to prevent staining, and to prevent cracking, distortion, warping or other physical damage.

D. Handle and transport units in a position consistent with their shape and design in order to avoid excessive stresses which would cause cracking or damage.

PART 2 PRODUCTS

2.1 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.

C. Epoxy-Coated Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed bars, epoxy coated.

D. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

E. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

F. Supports: Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 117.

2.2 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type I or Type III, gray, unless otherwise indicated.

B. Normal-Weight Aggregates: Except as modified by PCI MNL 117, ASTM C 33, with coarse aggregates complying with Class 5S. Stockpile fine and coarse aggregates for each type of

exposed finish from a single source (pit or quarry) for Project.

C. Lightweight Aggregates: Except as modified by PCI MNL 117, ASTM C 330, with absorption less than 11 percent.

D. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 117.

E. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

2.3 GROUT MATERIALS

A. Sand-Cement Grout: Portland cement, ASTM C 150, Type I, and clean, natural sand, ASTM C 144 or ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

2.4 CONCRETE MIXTURES

A. Prepare design mixtures for each type of precast concrete required.

B. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at architectural precast concrete fabricator's option.

C. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by ACI 318 (ACI 318M) or PCI MNL 117 when tested according to ASTM C 1218/C 1218M.

D. Normal-Weight Concrete Mixtures: Proportion mixes by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:
   1. Compressive Strength (28 Days): 5000 psi (34.5 MPa) minimum.
   2. Maximum Water-Cementitious Materials Ratio: 0.45.

E. Water Absorption: 6 percent by weight or 14 percent by volume, tested according to PCI MNL 117.

F. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 117.

2.5 FINISHES

A. Finish exposed-face surfaces of precast architectural concrete units to match approved design reference sample and as follows:
   1. Smooth-Surface Finish: Free of pockets, sand streaks, and honeycombs, with uniform color and texture.

B. Finish exposed top, side, and end surfaces of precast architectural concrete units to match

face-surface finish.

2.6 FABRICATION

A. Reinforcement: Comply with recommendations in PCI MNL 117 for fabricating, placing, and supporting reinforcement.

B. Reinforce architectural precast concrete units to resist handling, transportation, and erection stresses.

C. Comply with requirements in PCI MNL 117 and requirements in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.

D. Place concrete in a continuous operation to prevent seams or planes of weakness from forming in precast concrete units.

E. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air on surfaces. Use equipment and procedures complying with PCI MNL 117.

F. Comply with PCI MNL 117 for hot- and cold-weather concrete placement.

G. Identify pickup points of architectural precast concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each architectural precast concrete unit on a surface that will not show in finished structure.

H. Cure concrete, according to requirements in PCI MNL 117, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.

I. Discard and replace architectural precast concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 117 and Architect's approval.

J. Provide continuous indented drip edge along underside of exposed edges, typ.

2.7 FABRICATION TOLERANCES

A. Fabricate architectural precast concrete units straight and true to size and shape with exposed edges and corners precise and true so each finished panel complies with PCI MNL 117 product tolerances as well as position tolerances for cast-in items.

2.8 SOURCE QUALITY CONTROL

A. Quality-Control Testing: Test and inspect precast concrete according to PCI MNL 117 requirements. If using self-consolidating concrete, also test and inspect according to PCI TR-6, "Interim Guidelines for the Use of Self-Consolidating Concrete in Precast/Prestressed Concrete Institute Member Plants."

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, true and level bearing surfaces, and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Grouting Connections: Grout connections where required or indicated. Retain grout in place until hard enough to support itself. Pack spaces with stiff grout material, tamping until voids are completely filled. Place grout to finish smooth, level, and plumb with adjacent concrete surfaces. Keep grouted joints damp for not less than 24 hours after initial set. Promptly remove grout material from exposed surfaces before it affects finishes or hardens.

3.3 REPAIRS

A. Repair architectural precast concrete units if permitted by Architect. The Architect reserves the right to reject repaired units that do not comply with requirements.

B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 feet (6 m).

C. Remove and replace damaged architectural precast concrete units when repairs do not comply with requirements.

3.4 CLEANING

A. Clean surfaces of precast concrete units exposed to view.

B. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.

END OF SECTION 034500

SECTION 040110 - MASONRY CLEANING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes cleaning the following:
   1. Unit masonry surfaces.

1.3 DEFINITIONS

A. Low-Pressure Spray: 100 to 400 psi.

1.4 SEQUENCING AND SCHEDULING

A. Work Sequence: Perform masonry-cleaning work in the following sequence:
   1. Inspect for open mortar joints. Where repairs are required, delay further cleaning work until after repairs are completed, cured, and dried to prevent the intrusion of water and other cleaning materials into the wall.
   2. Clean masonry surfaces.
   3. Where water repellents are to be used on or near masonry, delay application of these chemicals until after cleaning.

B. As scaffolding is removed, patch anchor holes used to attach scaffolding. Patch holes in masonry units according to masonry repair Sections. Patch holes in mortar joints according to masonry repointing Sections.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include material descriptions and application instructions.
   2. Include test data substantiating that products comply with requirements.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For paint-remover manufacturer and chemical-cleaner manufacturer.

B. Preconstruction Test Reports: For cleaning materials and methods.

C. Cleaning program.

1.7 QUALITY ASSURANCE

A. Chemical-Cleaner Manufacturer Qualifications: A firm regularly engaged in producing masonry cleaners that have been used for similar applications with successful results, and with factory-authorized service representatives who are available for consultation and Project-site inspection, preconstruction product testing, and on-site assistance.

B. Cleaning Program: Prepare a written cleaning program that describes cleaning process in detail, including materials, methods, and equipment to be used; protection of surrounding materials; and control of runoff during operations. Include provisions for supervising worker performance and preventing damage.
   1. If materials and methods other than those indicated are proposed for any phase of cleaning work, add a written description of such materials and methods, including evidence of successful use on comparable projects and demonstrations to show their effectiveness for this Project.

1.8 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit masonry-cleaning work to be performed according to product manufacturers' written instructions and specified requirements.

B. Clean masonry surfaces only when air temperature is 40 deg F and above and is predicted to remain so for at least seven days after completion of cleaning.

PART 2 PRODUCTS

2.1 CLEANING MATERIALS

A. Water: Potable.

B. Hot Water: Water heated to a temperature of 140 to 160 deg F.

C. Mold, Mildew, and Algae Remover, Job Mixed: Solution prepared by mixing 2 cups of tetrasodium pyrophosphate (TSPP), 5 quarts of 5 percent sodium hypochlorite (bleach), and 15 quarts of hot water for every 5 gal. of solution required.

D. Nonacidic Liquid Cleaner: Manufacturer's standard mildly alkaline liquid cleaner formulated for removing mold, mildew, and other organic soiling from ordinary building materials, including polished stone, brick, aluminum, plastics, and wood.

2.2 ACCESSORY MATERIALS

A. Liquid Strippable Masking Agent: Manufacturer's standard liquid, film-forming, strippable masking material for protecting glass, metal, glazed masonry, and polished stone surfaces from damaging effects of acidic and alkaline masonry cleaners.

2.3 CHEMICAL CLEANING SOLUTIONS

A. Dilute chemical cleaners with water to produce solutions not exceeding concentration recommended in writing by chemical-cleaner manufacturer.

B. Acidic Cleaner Solution for Nonglazed Masonry: Dilute acidic cleaner with water to produce hydrofluoric acid content of 3 percent or less, but not greater than that recommended in writing by chemical-cleaner manufacturer.
   1. Stones: Use only on unpolished granite, unpolished dolomite marble, and siliceous sandstone.

C. Acidic Cleaner for: Dilute acidic cleaner with water to concentration demonstrated by testing that does not etch or otherwise damage glazed or polished surface, but not greater than that recommended in writing by chemical-cleaner manufacturer.
   1. Stones: Use only on polished granite and polished dolomite marble.

PART 3 EXECUTION

3.1 PROTECTION

A. Comply with each manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products. Prevent paint removers and chemical cleaning solutions from coming into contact with people, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.
   1. Cover adjacent surfaces with materials that are proven to resist paint removers and chemical cleaners used unless products being used will not damage adjacent surfaces. Use protective materials that are waterproof and UV resistant. Apply masking agents according to manufacturer's written instructions. Do not apply liquid strippable masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.
   2. Do not apply chemical solutions during winds of enough force to spread them to unprotected surfaces.
   3. Neutralize alkaline and acid wastes before disposal.
   4. Dispose of runoff from operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

B. Remove gutters and downspouts and associated hardware adjacent to immediate work area and store during masonry cleaning. Reinstall when masonry cleaning is complete.
   1. Provide temporary rain drainage during work to direct water away from building.

3.2 CLEANING MASONRY, GENERAL

A. Cleaning Appearance Standard: Cleaned surfaces are to have a uniform appearance as viewed from 20 feet away by Architect.

B. Proceed with cleaning in an orderly manner; work from bottom to top of each scaffold width and from one end of each elevation to the other. Ensure that dirty residues and rinse water do not wash over dry, cleaned surfaces.

C. Use only those cleaning methods indicated for each masonry material and location.
   1. Brushes: Do not use wire brushes or brushes that are not resistant to chemical cleaner being used.
   2. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that cleaning methods do not damage surfaces, including joints.
      a. Equip units with pressure gages.
      b. For chemical-cleaner spray application, use low-pressure tank or chemical pump suitable for chemical cleaner indicated, equipped with nozzle having a cone-shaped spray.
      c. For water-spray application, use fan-shaped spray that disperses water at an angle of 25 to 50 degrees.
      d. For heated water-spray application, use equipment capable of maintaining temperature between 140 and 160 deg F at flow rates indicated.

D. Perform each cleaning method indicated in a manner that results in uniform coverage of all surfaces, including corners, moldings, and interstices, and that produces an even effect without streaking or damaging masonry surfaces. Keep wall wet below area being cleaned to prevent streaking from runoff.

E. Perform additional general cleaning, paint and stain removal, and spot cleaning of small areas that are noticeably different when viewed according to the "Cleaning Appearance Standard" Paragraph, so that cleaned surfaces blend smoothly into surrounding areas.

F. Water Application Methods:
   1. Water-Spray Applications: Unless otherwise indicated, hold spray nozzle at least 6 inches from masonry surface and apply water in horizontal back-and-forth sweeping motion, overlapping previous strokes to produce uniform coverage.

G. Chemical-Cleaner Application Methods: Apply chemical cleaners to masonry surfaces according to chemical-cleaner manufacturer's written instructions; use brush application. Do not allow chemicals to remain on surface for periods longer than those indicated or recommended in writing by manufacturer.

H. Rinse off chemical residue and soil by working upward from bottom to top of each treated area at each stage or scaffold setting. Periodically during each rinse, test pH of rinse water running off of cleaned area to determine that chemical cleaner is completely removed.
   1. Apply neutralizing agent and repeat rinse if necessary to produce tested pH of between 6.7 and 7.5.

I. After cleaning is complete, remove protection no longer required. Remove tape and adhesive

marks.

3.3 PRELIMINARY CLEANING

A. Preliminary Cleaning: Before beginning general cleaning, remove extraneous substances that are resistant to planned cleaning methods. Extraneous substances include paint, calking, asphalt, and tar.
   1. Carefully remove heavy accumulations of rigid materials from masonry surface with sharp chisel. Do not scratch or chip masonry surface.
   2. Remove paint and calking with solvent-type paste paint remover.
      a. Repeat application up to two times if needed.
   3. Remove asphalt and tar with solvent-type paste paint remover.
      a. Apply paint remover only to asphalt and tar by brush without prewetting.
      b. Allow paint remover to remain on surface for 10 to 30 minutes.
      c. Repeat application if needed.

3.4 CLEANING MASONRY

A. Cold-Water Wash: Use cold water applied by low-pressure spray.

B. Hot-Water Wash: Use hot water applied by low-pressure spray.

C. Mold, Mildew, and Algae Removal:
   1. Wet surface with cold water applied by low-pressure spray.
   2. Apply mold, mildew, and algae remover by brush or low-pressure spray.
   3. Scrub surface with medium-soft brushes until mold, mildew, and algae are thoroughly dislodged and can be removed by rinsing. Use small brushes for mortar joints and crevices. Dip brush in mold, mildew, and algae remover often to ensure that adequate fresh cleaner is used and that surface remains wet.
   4. Rinse with cold water applied by low-pressure spray to remove mold, mildew, and algae remover and soil.
   5. Repeat cleaning procedure above where required to produce cleaning effect established by mockup.

D. Nonacidic Liquid Chemical Cleaning:
   1. Wet surface with water applied by low-pressure spray.
   2. Apply cleaner to surface in two applications by brush.
   3. Let cleaner remain on surface for period recommended in writing by chemical-cleaner manufacturer.
   4. Rinse with cold water applied by low-pressure spray to remove chemicals and soil.
   5. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.

3.5 FINAL CLEANING

A. Remove debris from enclosed crawlspace. Rinse off any other surrounding/adjacent

waterproof building materials.

B. Remove masking materials, leaving no residues that could trap dirt.

C. Leave a clean and dry work area.

END OF SECTION 040110

SECTION 042000 - -UNIT MASONRY

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Concrete masonry units.
   2. Decorative concrete masonry units.
   3. Face brick.
   4. Mortar and grout.
   5. Steel reinforcing bars.
   6. Masonry joint reinforcement.
   7. Ties and anchors.
   8. Embedded flashing.
   9. Miscellaneous masonry accessories.
   10. Cavity-wall insulation.

B. Related Sections:
   1. Section 051200 "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural steel frame.
   2. Section 076200 "Sheet Metal Flashing and Trim" for exposed sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.

1.3 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PERFORMANCE REQUIREMENTS

A. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days.
   1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.
   2. Determine net-area compressive strength of masonry by testing masonry prisms according to ASTM C 1314.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For the following:
   1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
   2. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.
   3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

C. Samples for Initial Selection:
   1. Face brick, in the form of straps of five or more bricks.
   2. Colored mortar.
   3. Weep holes/vents.

D. Samples for Verification: For each type and color of the following:
   1. Exposed CMUs.
   2. Face brick, in the form of straps of five or more bricks.
   3. Special brick shapes.
   4. Pigmented mortar. Make Samples using same sand and mortar ingredients to be used on Project.
   5. Weep holes and vents.
   6. Accessories embedded in masonry.

1.6 INFORMATIONAL SUBMITTALS

A. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.
   1. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.

B. Qualification Data: For testing agency.

C. Material Certificates: For each type and size of the following:
   1. Masonry units.
      a. Include data on material properties.
      b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
      c. For exposed brick, include test report for efflorescence according to ASTM C 67.
      d. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
   2. Cementitious materials. Include brand, type, and name of manufacturer.
   3. Pre-blended, dry mortar mixes. Include description of type and proportions of ingredients.
   4. Grout mixes. Include description of type and proportions of ingredients.

5. Reinforcing bars.
6. Joint reinforcement.
7. Anchors, ties, and metal accessories.

D. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
   1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
   2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

E. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.

F. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.

B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

D. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

E. Sample Panels: Build sample panels to verify selections made under sample submittals and to demonstrate aesthetic effects. Comply with requirements in Section 014000 "Quality Requirements" for mockups.
   1. Build sample panels for each type of exposed unit masonry construction in sizes approximately 60 inches (1500 mm) long by 48 inches (1200 mm) high by full thickness.
   2. Where masonry is to match existing, erect panels adjacent and parallel to existing surface.
   3. Clean one-half of exposed faces of panels with masonry cleaner indicated.
   4. Protect approved sample panels from the elements with weather-resistant membrane.
   5. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing.

a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels unless such deviations are specifically approved by Architect in writing.

F. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Build mockups for each type of exposed unit masonry construction in sizes approximately 60 inches (1500 mm) long by 60 inches (1500 mm) high by full thickness, including face and backup wythes and accessories.
a. Include a sealant-filled joint at least 16 inches (400 mm) long in each exterior wall mockup.
b. Include lower corner of window opening at upper corner of exterior wall mockup. Make opening approximately 12 inches (300 mm) wide by 16 inches (400 mm) high.
c. Include through-wall flashing installed for a 24-inch (600-mm) length in corner of exterior wall mockup approximately 16 inches (400 mm) down from top of mockup, with a 12-inch (300-mm) length of flashing left exposed to view (omit masonry above half of flashing).
d. Include metal studs, sheathing, sheathing joint-and-penetration treatment air barrier, veneer anchors, flashing, cavity drainage material, and weep holes in exterior masonry-veneer wall mockup.
2. Clean one-half of exposed faces of mockups with masonry cleaner as indicated.
3. Protect accepted mockups from the elements with weather-resistant membrane.
4. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.
b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Architect in writing.
5. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

G. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination."

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.9 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
   1. Extend cover a minimum of 24 inches (600 mm) down both sides of walls and hold cover securely in place.
   2. Where one wythe of multi-wythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches (600 mm) down face next to unconstructed wythe and hold cover in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
   1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
   2. Protect sills, ledges, and projections from mortar droppings.
   3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
   4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
   1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 PRODUCTS

2.1 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

B. Fire-Resistance Ratings: Where indicated, provide units that comply with requirements for fire-resistance ratings indicated as determined by testing according to ASTM E 119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

2.2 CONCRETE MASONRY UNITS

A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
   1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
   2. Provide bullnose units for outside corners unless otherwise indicated.

B. Integral Water Repellent: Provide units made with integral water repellent for exposed units.
   1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested in accordance with ASTM E514/E514M as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, will show no visible water or leaks on the back of test specimen.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) ACM Chemistries.
         2) Euclid Chemical Company (The); an RPM company.
         3) GCP Applied Technologies Inc.

C. CMUs: ASTM C 90.
   1. Density Classification: Lightweight unless otherwise indicated.
   2. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.
   3. Size (Width): Manufactured to the following dimensions:
      a. 16 inches by 8 inches by 8 inches deep, nominal.
      b. 16 inches by 8 inches by 12 inches deep, nominal.
   4. Texture: Ground-face and sealed.
   5. Match Architect's samples.

2.3 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

B. Hydrated Lime: ASTM C 207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Mortar Cement: ASTM C 1329.
   1. Brick mortar color 1: Match architect's sample.
   2. Brick mortar color 2: Match architect's sample.

E. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979. Use only pigments with a record of satisfactory performance in masonry mortar.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Davis Colors; True Tone Mortar Colors.
      b. Lanxess Corporation; Bayferrox Iron Oxide Pigments.
      c. Solomon Colors, Inc.; SGS Mortar Colors.

F. Aggregate for Mortar: ASTM C 144.
   1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
   2. For joints less than ¼-inch (6 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.

G. Aggregate for Grout: ASTM C 404.

H. Water: Potable.

2.4 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60 (Grade 420).

B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.
   1. Interior Walls: Mill- galvanized, carbon steel.
   2. Exterior Walls: Hot-dip galvanized, carbon steel.
   3. Wire Size for Side Rods: 0.187-inch (4.76-mm) diameter.
   4. Wire Size for Cross Rods: 0.187-inch (4.76-mm) diameter.
   5. Wire Size for Veneer Ties: 0.187-inch (4.76-mm) diameter.
   6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches (407 mm) o.c.
   7. Provide in lengths of not less than 10 feet (3 m), with prefabricated corner and tee units.

C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.

D. Masonry Joint Reinforcement for Multi-wythe Masonry:
   1. Adjustable (two-piece) type, either ladder or truss design, with one side rod at each face shell of backing wythe and with separate adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches (32 mm). Size ties to extend at least halfway through facing wythe but with at least 5/8-inch (16-mm) cover on outside face.

Ties have hooks or clips to engage a continuous horizontal wire in the facing wythe.

2.5 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.
   1. Mill-Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 641/A 641M, Class 1 coating.
   2. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 153/A 153M, Class B-2 coating.
   3. Stainless-Steel Wire: ASTM A 580/A 580M, Type 316.
   4. Galvanized Steel Sheet: ASTM A 653/A 653M, Commercial Steel, G60 (Z180) zinc coating.
   5. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.
   6. Stainless-Steel Sheet: ASTM A 666, Type 304.
   7. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
   8. Stainless-Steel Bars: ASTM A 276 or ASTM a 666, Type 316.

B. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
   1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch-(6.35-mm-) diameter, hot-dip galvanized steel wire. Mill-galvanized wire may be used at interior walls unless otherwise indicated.
   2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch (25 mm) of masonry face, made from 0.25-inch-(6.35-mm-) diameter, hot-dip galvanized steel wire. Mill-galvanized wire may be used at interior walls unless otherwise indicated.

C. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
   1. Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 01.05-inch-(2.66-mm-) thick, steel sheet, galvanized after fabrication.
      a. 0.064-inch-(1.63-mm-) thick, galvanized sheet may be used at interior walls unless otherwise indicated.

D. Partition Top anchors: 0.105-inch-(2.66-mm-)thick metal plate with 3/8-inch-(9.5-mm-) diameter metal rod 6 inches (152 mm) long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.

E. Adjustable Masonry-Veneer Anchors:
   1. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:
      a. Structural Performance Characteristics: Capable of withstanding a 100-lbf (445-N) load in both tension and compression without deforming or developing play in

excess of 0.05 inch (1.3 mm).

2. Fabricate sheet metal anchor sections and other sheet metal parts from 1.05-inch-(2.66-mm-)thick steel sheet, galvanized after fabrication.
3. Wire Ties: Triangular-, rectangular-, or T-shaped wire ties fabricated from 0.25-inch-(6.35-mm-) diameter, hot-dip galvanized-steel wire unless otherwise indicated.
4. Contractor's Option: Unless otherwise indicated, provide any of the following types of anchors:
    a. Slip-in, Masonry-Veneer Anchors: Units consisting of a wire tie section and an anchor section designed to interlock with metal studs and be slipped into place as sheathing is installed.
    b. Stainless-Steel Drill Screws for Steel Studs: Proprietary fastener consisting of carbon-steel drill point and 300 Series stainless-steel shank, complying with ASTM C 954 except manufactured with hex washer head and neoprene or EPDM washer, No. 10 (4.83-mm) diameter by length required to penetrate steel stud flange with not less than three exposed threads.

2.6 MISCELLANEOUS ANCHORS

A. Post-installed Anchors: Torque-controlled expansion anchors.
    1. Load Capacity: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
    2. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5 unless otherwise indicated.
    3. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group (2) A4 stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

2.7 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" Section 076200 "Sheet Metal Flashing and Trim" " and as follows:
    1. Stainless Steel: ASTM A 240/A 240M, Type 304, 0.016 inch (0.40 mm) thick.
    2. Fabricate continuous flashings in sections 96 inches (2400 mm) long minimum, but not exceeding 12 feet (3.7 m). Provide splice plates at joints of formed, smooth metal flashing.
    3. Fabricate through-wall metal flashing embedded in masonry from stainless steel, with ribs at 3-inch (76-mm) intervals along length of flashing to provide an integral mortar bond.
        a. Products: Subject to compliance with requirements, provide one of the following:
            1) Cheney Flashing Company.
            2) Keystone Flashing Company, Inc.; Keystone 3-Way Interlocking Thru-wall Flashing.
            3) Sandell Manufacturing Co., Inc.; Mechanically Keyed Flashing.

4. Fabricate through-wall flashing with snap-lock receiver on exterior face where indicated to receive counterflashing.
5. Fabricate through-wall flashing with drip edge unless otherwise indicated. Fabricate by extending flashing 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed.
6. Fabricate through-wall flashing with sealant stop unless otherwise indicated. Fabricate by bending metal back on itself 3/4 inch (19 mm) at exterior face of wall and down into joint 1/4 inch (6 mm) to form a stop for retaining sealant backer rod.
7. Metal Drip Edge: Fabricate from stainless steel. Extend at least 3 inches (76 mm) into wall and 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed.
8. Metal Sealant Stop: Fabricate from stainless steel. Extend at least 3 inches (76 mm) into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch (19 mm) and down into joint 1/4 inch (6 mm) to form a stop for retaining sealant backer rod.
9. Metal Expansion-Joint Strips: Fabricate from stainless steel to shapes indicated.

B. Application: Unless otherwise indicated, use the following:
1. Where flashing is indicated to receive counterflashing, use metal flashing.
2. Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing.
3. Where flashing is partly exposed and is indicated to terminate at the wall face, use metal flashing with a drip edge.
4. Where flashing is fully concealed, use metal flashing.

C. Single-Wythe CMU Flashing System: System of CMU cell flashing pans and interlocking CMU web covers made from high-density polyethylene incorporating chemical stabilizers that prevent UV degradation. Cell flashing pans have integral weep spouts that are designed to be built into mortar bed joints and weep collected moisture to the exterior of CMU walls and that extend into the cell to prevent clogging with mortar.

D. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.8 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Pre-molded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene, urethane, or PVC.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

D. Weep/Vent Products: Use the following unless otherwise indicated:
   1. Rectangular Plastic Weep/Vent Tubing: Clear butyrate, 3/8 by 1-1/2 by 3-1/2 inches (9 by 38 by 89 mm) long.

E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
   1. Provide one of the following configurations:
      a. Strips, full-depth of cavity and 10 inches (250 mm) high, with dovetail shaped notches 7 inches (175 mm) deep that prevent clogging with mortar droppings.

F. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and hold reinforcing bars in center of cells. Units are formed from 0.148-inch (3.77-mm) steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Dayton Superior Corporation, Dur-O-Wal Division; D/A 810, D/A 812 or D/A 817.
      b. Heckmann Building Products Inc.; No. 376 Rebar Positioner.
      c. Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner.
      d. Wire-Bond; O-Ring or Double O-Ring Rebar Positioner.

G. High-Performance Architectural Latex System.
   1. Block Filler: Interior/exterior latex block filler.
   2. Prime Coat: Alkali-resistant, water-based primer.
   3. Intermediate Coat: Matching topcoat.
   4. Topcoat: Interior, latex, high-performance architectural coating, eggshell.

2.9 CAVITY-WALL INSULATION

A. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV unless otherwise indicated, closed-cell product extruded with an integral skin.

B. Adhesive: Type recommended by insulation board manufacturer for application indicated.

2.10 MASONRY CLEANERS

A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Diedrich Technologies, Inc.
      b. EaCo Chem, Inc.
      c. ProSoCo, Inc.

2.11 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
   1. Do not use calcium chloride in mortar or grout.
   2. Use portland cement-lime or mortar cement mortar unless otherwise indicated.
   3. For exterior masonry, use portland cement-lime or mortar cement mortar.
   4. For reinforced masonry, use portland cement-lime or mortar cement mortar.
   5. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Pre-blended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a pre-blended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
   1. For masonry below grade or in contact with earth, use Type S.
   2. For reinforced masonry, use Type S.
   3. For mortar parge coats, use Type N.
   4. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.
   5. For interior non-load-bearing partitions, Type O may be used instead of Type N.

D. Pigmented Mortar: Use colored cement product.
   1. Pigments shall not exceed 10 percent of portland cement by weight.
   2. Pigments shall not exceed 5 percent of mortar cement by weight.
   3. Mix to match Architect's sample.
   4. Application: Use pigmented mortar for exposed mortar joints with the following units:
      a. Face brick.

E. Grout for Unit Masonry: Comply with ASTM C 476.
   1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
   2. Proportion grout in accordance with ASTM C 476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi (14 MPa).
   3. Provide grout with a slump of 8 to 11 inches (203 to 279 mm) as measured according to ASTM C 143/C 143M.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
   2. Verify that foundations are within tolerances specified.
   3. Verify that reinforcing dowels are properly placed.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this and other Sections.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
   1. Mix units from several pallets or cubes as they are placed.

F. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:
   1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch (12 mm) or minus 1/4 inch (6 mm).
   2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch (12 mm).

3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch (6 mm) in a story height or 1/2 inch (12 mm) total.

B. Lines and Levels:
1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2 inch (12 mm) maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch (12 mm) maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch (12 mm) maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2 inch (12 mm) maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch (1.5 mm) except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:
1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm), with a maximum thickness limited to 1/2 inch (12 mm).
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch (3 mm).
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch (9 mm) or minus 1/4 inch (6 mm).
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm). Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch (3 mm).
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch (1.5 mm) from one masonry unit to the next.

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2 inches (50 mm). Bond and interlock each course of each wythe at corners. Do not

use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout 24 inches (600 mm) under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.
   1. Install compressible filler in joint between top of partition and underside of structure above.
   2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch (13-mm) clearance between end of anchor rod and end of tube. Space anchors 48 inches (1200 mm) o.c. unless otherwise indicated.
   3. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
   4. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078446 "Fire-Resistive Joint Systems."

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:
   1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
   2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
   3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
   4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.6 CAVITY WALLS

A. Bond wythes of cavity walls together using one of the following methods:
   1. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for 2.67 sq. ft. (0.25 sq. m) of wall area spaced not to exceed 24 inches (610 mm) o.c. horizontally and 16 inches (406 mm) o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches (305 mm) of openings and space not more than 36 inches (915 mm) apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches (610 mm) o.c. vertically.
      a. Where bed joints of wythes do not align, use adjustable (two-piece) type ties.
      b. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type ties to allow for differential movement regardless of whether bed joints align.
   2. Masonry Joint Reinforcement: Installed in horizontal mortar joints.
      a. Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes.
      b. Where bed joints of wythes do not align, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties.
      c. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties to allow for differential movement regardless of whether bed joints align.
   3. Header Bonding: Provide masonry unit headers extending not less than 3 inches (76 mm) into each wythe. Space headers not over 8 inches (203 mm) clear horizontally and 16 inches (406 mm) clear vertically.
   4. Masonry Veneer Anchors: Comply with requirements for anchoring masonry veneers.

B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.

C. Installing Cavity-Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches (300 mm) o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.
   1. Fill cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

3.7 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (150 mm).
   1. Space reinforcement not more than 16 inches (406 mm) o.c.
   2. Space reinforcement not more than 8 inches (203 mm) o.c. in foundation walls and parapet walls.
   3. Provide reinforcement not more than 8 inches (203 mm) above and below wall openings and extending 12 inches (305 mm) beyond openings in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.8 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:
   1. Provide an open space not less than 1 inch (25 mm) wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
   2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
   3. Space anchors as indicated, but not more than 24 inches (610 mm) o.c. vertically and 36 inches (915 mm) o.c. horizontally.

3.9 ANCHORING MASONRY VENEERS

A. Anchor masonry veneers to wall framing and concrete and masonry backup with masonry-veneer anchors to comply with the following requirements:
   1. Fasten screw-attached anchors to concrete and masonry backup with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
   2. Insert slip-in anchors in metal studs as sheathing is installed. Provide one anchor at each stud in each horizontal joint between sheathing boards.
   3. Embed tie sections, connector sections and continuous wire in masonry joints. Provide not less than 2 inches (50 mm) of air space between back of masonry veneer and face of sheathing.
   4. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
   5. Space anchors as indicated, but not more than 18 inches (458 mm) o.c. vertically and 24 inches (610 mm) o.c. horizontally, with not less than 1 anchor for each 2 sq. ft. (0.2 sq. m) of wall area. Install additional anchors within 12 inches (305 mm) of openings and at

intervals, not exceeding 8 inches (203 mm), around perimeter.

6. Space anchors as indicated, but not more than 16 inches (406 mm) o.c. vertically and 24 inches (610 mm) o.c. horizontally with not less than 1 anchor for each 2.67 sq. ft. (0.25 sq. m) of wall area. Install additional anchors within 12 inches (305 mm) of openings and at intervals, not exceeding 36 inches (914 mm), around perimeter.

3.10 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry using one of the following methods:
   1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.
   2. Install preformed control-joint gaskets designed to fit standard sash block.
   3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.
   4. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.

C. Form expansion joints in brick as follows:
   1. Build flanges of metal expansion strips into masonry. Lap each joint 4 inches (100 mm) in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
   2. Build flanges of factory-fabricated, expansion-joint units into masonry.
   3. Build in compressible joint fillers where indicated.
   4. Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch (10 mm) for installation of sealant and backer rod specified in Division 07 Section "Joint Sealants."

D. Provide horizontal, pressure-relieving joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Division 07 Section "Joint Sealants," but not less than 3/8 inch (10 mm).
   1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.11 LINTELS

A. Install steel lintels where indicated.

B. Provide concrete or masonry lintels where shown and where openings of more than 12 inches (305 mm) for brick-size units and 24 inches (610 mm) for block-size units are shown without structural steel or other supporting lintels.

C. Provide minimum bearing of 8 inches (200 mm) at each jamb unless otherwise indicated.

3.12 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.

B. Install flashing as follows unless otherwise indicated:
   1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
   2. At multi-wythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 8 inches (200 mm), and through inner wythe to within 1/2 inch (13 mm) of the interior face of wall in exposed masonry. Where interior face of wall is to receive furring or framing, carry flashing completely through inner wythe and turn flashing up approximately 2 inches (50 mm) on interior face.
   3. At masonry-veneer walls, extend flashing through veneer, across air space behind veneer, and up face of sheathing at least 8 inches (200 mm); with upper edge tucked under building paper or building wrap, lapping at least 4 inches (100 mm).
   4. At lintels and shelf angles, extend flashing a minimum of 6 inches (150 mm) into masonry at each end. At heads and sills, extend flashing 6 inches (150 mm) at ends and turn up not less than 2 inches (50 mm) to form end dams.
   5. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches (38 mm) or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
   6. Install metal drip edges and sealant stops with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.

C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

D. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

E. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:
   1. Use specified weep/vent products to form weep holes.
   2. Space weep holes 24 inches (600 mm) o.c. unless otherwise indicated.

F. Place pea gravel in cavities as soon as practical to a height equal to height of first course above top of flashing, but not less than 2 inches (50 mm), to maintain drainage.

G. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.

H. Install vents in head joints in exterior wythes at spacing indicated. Use specified weep/vent products to form vents.
   1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.13 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
   1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
   2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
   1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
   2. Limit height of vertical grout pours to not more than 60 inches (1520 mm).

3.14 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
   1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
   2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.

3. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
4. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
5. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.15 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

END OF SECTION 042000

SECTION 044300.13 - LANDSCAPE BOULDERS

1.1 SUMMARY

A. Section Includes:

1. Landscape boulders.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved for installation of landscape boulders required for this Project.

B. Product Data: Landscape Boulders shall be supplied from local stone supplier.

C. Preinstallation Conference: Conduct at Project site.

1. Review methods and procedures related to landscape boulders including, but not limited to, the following:

a. Landscape boulder installation
b. Landscape boulder location and orientation.

1.3 MATERIALS

A. Landscape Boulders: - Provide sound, durable natural boulders to match color of existing dry stacked retaining wall, supplied by Stone Center, Lawn-N-Orde, Preferred Lawn and Garden or approved equal.

B. For all materials, Landscape Architect to select boulders from stone supplier.

C. Final selection and location of landscape boulders shall be determined in the field under the direction of the Landscape Architect. Refer to Drawings for approximate quantity, size and locations.

1.4 INSTALLATION

A. Leveling Base: Place and compact base material to thickness indicated and with not less than 95 percent maximum dry unit weight according to ASTM D 698.

B. Install boulders in locations as directed by Landscape Architect in the field. Bury boulders to a depth equal to 1/3 of the boulder’s height.

END OF SECTION 044300.13

SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Structural steel.
   2. Field-installed shear connectors and deformed bar anchors.
   3. Grout for column base plates.

B. Related Requirements:
   1. Section 014100 “Special Inspection Services” for administrative and procedural requirements for special inspection services.
   2. Section 053100 “Steel Decking” for field installation of shear connectors through deck.
   3. Section 099600 “High-performance Coatings” for surface-preparation and priming requirements of members to receive high performance coatings.

1.3 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame indicated on Drawings and as described in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

1.4 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

A. Shop Drawings: Show fabrication of structural-steel components.
   1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
   2. Provide setting drawings, templates, and directions for installation of anchor bolts and other anchorages to be installed as work of other sections.
   3. Include embedment drawings.
   4. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
   5. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
   6. Delegated design submittals must be submitted with or prior to shop drawings. Shop drawings will not be reviewed until delegated design submittals have been submitted.

B. Delegated-Design Submittal: For structural-steel connections indicated as “delegated design”, include structural calculations signed and sealed by the qualified professional engineer responsible for their preparation. In addition, the professional engineer responsible for connection design shall review the shop drawings prior to submittal for review to verify that the connections as detailed on the shop drawings comply with the connection design requirements of the final calculations. A review letter, signed and sealed by the professional engineer responsible for connection design shall be provided with the shop drawing and calculation submittal stating that this review and verification has been completed.

1.7 INFORMATION SUBMITTALS

A. Qualification Data: For qualified fabricator.

B. Welding certificates. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the “Quality Assurance” Article.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Mill test reports for structural steel, including chemical and physical properties.

E. Product Test Reports: For the following:

F. 1. Bolts, nuts, and washers including mechanical properties and chemical analysis.

G. 2. Direct-tension indicators.

H. 3. Tension-control, high-strength, bolt-nut-washer assemblies.

I. 4. Deformed Bar Anchors.

J. 5. Shop primers.

K. 6. Non-shrink grout.

1.8 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.
   1. Exception: The fabricator maintains detailed fabrication and quality control procedures which provide a basis for inspection control of the workmanship and the fabricator’s ability to conform to approved drawings, project specifications and referenced standards.
   2. The Owner’s Special Inspection Agency shall review the procedures to the completeness and adequacy relative to the Code requirements including Special Inspection requirements for the fabricators scope of work.

B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Comply with applicable provisions of the following specifications and documents:
   1. AISC 303.
   2. AISC 360.
   3. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
   1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
   1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
   2. Clean and relubricate bolts and nuts that become dry or rusty before use.
   3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

1.10 PERFORMANCE REQUIREMENTS

A. Connections: Provide details of simple shear, braced frame, moment frame and lintel/girt connections required by the Contract Documents to be selected or completed by structural-steel fabricator, including comprehensive engineering design by a qualified professional engineer, to withstand loads indicated and comply with other information and restrictions indicated.
   1. Select and complete connections using schematic details indicated and AISC 360.
   2. Use LRFD; data are given at strength-load level.

PART 2 PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A 992, Grade 50.

B. Channels, Angles: ASTM A 36, Grade 36.

C. Plate and Bar: ASTM A 36, Grade 36.

D. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade C, structural tubing, square, and rectangular.

E. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural round shape.

F. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; all with plain finish.

B. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex round head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.
   1. Finish: Plain, unless otherwise noted.

C. Deformed Bar Anchors: ASTM A 1064; AWS D1.1, Type C.

D. Headed Anchor Rods: ASTM F 1554, Grade 36, weldable, straight.
   1. Nuts: ASTM A 563 heavy-hex carbon steel.
   2. Plate Washers: ASTM A 36/A 36M carbon steel.
   3. Washers: ASTM F 436, Type 1, hardened carbon steel.
   4. Finish: Plain.

2.3 PRIMER

A. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and requirements for low-emitting materials, compatible with topcoat where members are exposed on interior.

B. At all structural steel and miscellaneous steel framing in natatorium and associated pool equipment and storage rooms, provide the following:
   1. SSPC-SP6 Commercial Blast Cleaning.
   2. One coat of Tnemec Series 90-97 Tneme-Zinc at 2.5 - 3.5 dry mils.
   3. One coat of Tnemec Series 161 Tneme-Fascure at 4.0 - 5.0 dry mils.

4. Refer to High Performance Coatings specification section for field painting.

C. For all steel to receive field-applied insulating coating, refer to High Performance Coatings specification section for primer and coating system.

D. For all steel to receive field-applied intumescent or spray-applied fireproofing, refer to Division 7 fireproofing specification sections for primer and coating systems.

E. Galvanizing Repair Paint: ASTM A 780.

2.4 BLACK ASPHALTUM PAINT

A. Ultra high bond, single-component coal tar mastic for protecting steel below grade.

2.5 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

B. 1. 5,500 psi minimum compressive strength.

2.6 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.
   1. Camber structural-steel members where indicated.
   2. Fabricate beams with rolling camber up.
   3. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
   4. Mark and match-mark materials for field assembly.
   5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
   1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

C. Bolt Holes: Cut, drill or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC SP 2, “Hand Tool Cleaning.” Clean and prepare steel surfaces that are to receive hot-dip galvanization according to SSPC-SP 2, “Hand Tool Cleaning” prior to galvanizing.

F. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.
   1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
   2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
   3. Weld threaded nuts to framing and other specialty items indicated to receive other work.
   4. Pavilion Columns:
   5. All factory welds to be ground smooth.
   6. Welded seams of columns to face the exterior of the pavilion.
   7. Bead blast tube to smooth surface.
   8. Prep surface of tube before painting.

2.7 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
   1. Joint Type: Snug tightened, unless otherwise indicated.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
   1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

2.8 SHOP PRIMING

A. Shop prime steel surfaces except the following:
   1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
   2. Surfaces to be field welded.
   3. Surfaces of high-strength bolted, slip-critical connections.
   4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
   5. Galvanized surfaces.
   6. Surfaces enclosed in interior construction.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
   1. SSPC-SP 2, "Hand Tool Cleaning."
   2. SSPC-SP 3, "Power Tool Cleaning."
   3. SSPC-SP 6, “Commercial Blast Cleaning” as noted for Tnemec shop primer and field painted areas.

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
   1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
   2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

2.9 GALVANIZING

A. Hot-Dip Galvanized Finish: Clean per requirements provided in specification. Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.
   1. Fill vent and drain holes that will be exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.
   2. Galvanize lintels, lintel assemblies and shelf angles located in exterior walls.

2.10 SPECIAL INSPECTIONS

A. Special Inspections and tests will be performed by the Owner’s Special Inspection Agency.
   1. Provide access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
   2. Verify that the fabricator maintains detailed fabrication and quality control procedures that provide a basis for inspection control of the workmanship and that those procedures are being implemented. This inspection will provide a basis for determination of fabricator’s ability to conform to approved drawings, project specifications, and referenced standards.
   3. a. Exception: Special Inspections will not be required where the work is done on the premises of a qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.
   4. 3. Approval shall be based upon review of the fabricator’s written procedural and quality control manuals and periodic auditing of fabrication practices.
   5. 4. At completion of fabrication, the fabricator shall submit a certificate of compliance stating that the work was performed in accordance with the approved construction documents.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
   1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.
   1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

B. Baseplates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials and roughen surfaces prior to setting plates. Clean bottom surface of plates.
   1. Set plates for structural members on wedges, shims, or setting nuts as required.
   2. Weld plate washers to top of baseplate.
   3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
   4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Apply two heavy coats of black asphaltum paint to all steel below grade.

D. Maintain erection tolerances of structural steel within AISC 303 "Code of Standard Practice for Steel Buildings and Bridges."

E. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
   1. Level and plumb individual members of structure.
   2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

F. Splice members only where indicated.

G. Do not use thermal cutting during erection unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.

H. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

I. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

J. Deformed Bar Anchors: Prepare steel surfaces as recommended by manufacturer of Deformed Bar Anchors. Use automatic end welding of Deformed Bar Anchors according to AWS D1.1 and manufacturer’s written instructions.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
   1. Joint Type: Snug tightened or fully pretensioned, as indicated.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
   1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
   2. Remove backing bars or runoff tabs where exposed to view in the final condition, back gouge, and grind steel smooth.
   3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC 303 "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

3.5 SPECIAL INSPECTIONS

A. Special Inspections and tests shall be performed by the Special Inspector or Special Inspection Agency.

B. Where fabrication of structural load-bearing members and assemblies is being performed on the premises of the fabricators shop, special inspection of the fabricated item shall be performed.
   1. Verify that the fabricator maintains detailed fabrication and quality control procedures that provide a basis for inspection control of the workmanship and that those procedures are being implemented. This inspection will provide a basis for determination of the fabricator’s ability to conform to approved drawings, project specifications, and referenced standards.
   2. Exception: Special Inspections will not be required where the work is done on the premises of a fabricator registered and approved to perform such work without special inspection. Approval shall be based upon review of the fabricator’s written procedural and quality control manuals and periodic auditing of fabrication practices. At completion of fabrication, the fabricator shall submit a certificate of compliance stating that the work was performed in accordance with the approved construction documents.

C. Verification and inspection of steel construction shall be in accordance with the requirements of the Statement of Special Inspections, Section 1705.2 of the 2018 North Carolina State Building Code, and as follows:
   1. Welding: Welding inspection shall be in compliance with AWS D1.1. In addition to visual inspection, welds may be tested and inspected according to AWS D1.1 and the following inspection procedures, at Special Inspector’s option:
      a. Liquid Penetrant Inspection: ASTM E 165.

b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
c. Ultrasonic Inspection: ASTM E 164.
d. Radiographic Inspection: ASTM E 94.

2. Details: Perform periodic inspections of the erected structural steel framing to verify compliance with the details shown on the construction documents and approved shop drawings such as member locations, size and spacing, connection details, bracing and bolted and welded connections.
3. High Strength Bolts: Bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
   a. General: While work is in progress, determine that the requirements for installation of bolts, nuts, washers and bolted parts are met. For bolts requiring pretensioning, observe the preinstallation testing and calibration procedures when such procedures are required by the installation method or by project plans or specifications; determine that all plies of connected materials have been drawn together and properly snugged and monitor the installation of bolts to verify that the selected procedure for installation is properly used to tighten bolts. For joints required to be tightened only to snug-tight condition, verify that the connected materials have been drawn together and properly snugged.
   b. Periodic monitoring: Monitoring of bolt installation for pretensioning is permitted to be performed on a periodic basis when using the turn-of-nut method with matchmarking techniques, the direct tension indicator method or the alternate design fastener (twist-off bolt) method. Joints designated as sung tight shall be inspected on a periodic basis.
   c. Continuous monitoring: Monitoring of bolt installation for pretensioning using the calibrated wrench method or the turn-of-nut method without matchmarking shall be performed on a continuous basis.

D. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

E. Additional testing performed to determine compliance of corrected work with specified requirements shall be at Contractor’s expense.

3.6 REPAIRS AND PROTECTION

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780.

B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-painted surfaces.
   1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

END OF SECTION 051200

SECTION 053100 - STEEL DECKING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Roof deck.

B. Related Requirements:
   1. Section 014100“Special Inspection Services” for administrative and procedural requirements for special inspection services.
   2. Section 033000 “Cast-in-Place Concrete” for normal weight structural concrete fill over steel deck.
   3. Section 051200 “Structural Steel Framing” for shop- and field-weld shear connectors.
   4. Section 099123 “Interior Painting” for repair painting of primed deck and finish painting of deck.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of deck, accessory, and product indicated.

B. Shop Drawings:

C. 1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Certificates: For each type of steel deck.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."

B. AISI Specifications: Comply with calculated structural characteristics of steel deck in accordance with AISI S100.

C. FM Global Listing: Provide steel roof deck evaluated by FM Global and listed in its "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Store products in accordance with SDI MOC3. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.
   1. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

1.7 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members.".

B. Steel roof deck shall be capable of resisting the following loads:
   1. Allowable total load: 80 PSF, minimum with 5'-6" span for 1-1/2" deck and 65 PSF minimum with 10'-0" span for 3" deck.

C. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

PART 2 PRODUCTS

2.1 TYPE N ROOF DECK

A. Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:

B. Retain one or more of the steel-sheet subparagraphs below to suit Project.
   1. Prime-Painted Steel Sheet: ASTM A1008/ASTM A 1008M, Structural Steel (SS), Grade 50 minimum, shop primed with manufacturer's standard baked-on, rust inhibitive primer. (275) (550).
   2. Deck Profile: Type N.
   3. Profile Depth: 3 inches.

4. Design Uncoated-Steel Thickness: As indicated on Drawings.
5. Span Condition: Triple span or more.
6. Side Laps: Overlapped.

2.2 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

D. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

E. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile indicated.

F. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.

G. Flat Sump Plate: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck. For drains, cut holes in the field.

H. Galvanizing Repair Paint: ASTM A 780.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.

B. Install temporary shoring before placing deck panels, if required to meet deflection limitations.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

E. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.

F. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

G. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

H. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

I. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

3.3 ROOF-DECK INSTALLATION

A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches long, and as follows:
   1. Weld Diameter: 5/8 inch, nominal.
   2. Weld Spacing: As indicated on drawings.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals indicated, and as follows:
   1. Mechanically fasten side laps with self-drilling, No. 10 diameter or larger, carbon-steel screws.
   2. Spacing: As indicated on Drawings.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:
   1. End Joints: Lapped 2 inches minimum.

D. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and weld flanges to top of deck. Space welds not more than 12 inches apart with at least one weld at each corner.
   1. Install reinforcing channels or zees in ribs to span between supports and weld.

E. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld to substrate to provide a complete deck installation.
   1. Weld cover plates at changes in direction of roof-deck panels, unless otherwise indicated.

3.4 SPECIAL INSPECTIONS

A. Special Inspections and tests shall be performed by the Special Inspector or Special Inspection Agency.

B. Verification and inspection of metal deck construction shall be in accordance with the Schedule of Special Inspections, Section 1705.2 of the 2018 North Carolina State Building Code, and as follows:
   1. Welding: Welding inspection shall be in compliance with AWS D1.3.
   2. Details: Perform periodic inspections of the installed steel decking to verify compliance with the details shown on the construction documents and approved shop drawings such as deck layout, gage, bearing, side laps, end laps and quantity and spacing of welds and screws.

C. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

D. Remove and replace work that does not comply with specified requirements.

E. Additional inspecting, at Contractor’s expense, will be performed to determine compliance of corrected work with specified requirements.

3.5 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION 053100

SECTION 054000 - COLD-FORMED METAL FRAMING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. All exterior non-load-bearing wall framing that receives lateral wind loading and gravity and lateral wind loading from windows, louvers, doors and other openings; including roof parapet wall studs.
   2. Exterior soffit and ceiling framing receiving wind load.

B. Related Requirements:
   1. Section 092216 "Non-Structural Metal Framing" for interior non-load-bearing, metal-stud framing and ceiling-suspension assemblies.

C. The Owner will engage an independent testing and inspection agency to perform tests and inspections, and verify the adequacy of the Contractor's quality control; refer to Section 01 40 00 "Quality Requirements." Before concealing the cold-formed metal framing work, obtain the required inspections from a representative of the Owner's independent testing and inspection agency.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of cold-formed steel framing product and accessory.

B. Shop Drawings:
   1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
   2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

C. Delegated Design:
   1. For cold-formed metal framing indicated to comply with design loads, include shop drawings and structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Certificates: For each type of code-compliance certification for studs and tracks.

C. Product Test Reports: For each listed product, for tests performed by manufacturer and witnessed by a qualified testing agency.
   1. Steel sheet.
   2. Expansion anchors.
   3. Power-actuated anchors.
   4. Mechanical fasteners.
   5. Vertical deflection clips.
   6. Horizontal drift deflection clips.
   7. Miscellaneous structural clips and accessories.

1.5 QUALITY ASSURANCE

A. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a qualified professional engineer.

B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of cold-formed metal framing that are similar to those indicated for this Project in material, design, and extent.

C. Installer Qualifications: Engage an experienced installer who has completed cold-formed metal framing on a minimum of three projects similar in material, design, and extent to that indicated for this Project in the last 10 years that have a record of successful in-service performance.

D. Product Tests: Mill certificates, signed by manufacturer, or data from a qualified independent testing agency, or in-house testing with calibrated test equipment, indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

E. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

F. AISI Specifications and Standards: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" and its "Standard for Cold-Formed Steel Framing - General Provisions."
   1. Comply with AISI's "Standard for Cold-Formed Steel Framing - Header Design."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling.

1.7 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 “Quality Requirements,” to design cold-formed steel framing.

B. Structural Performance: Provide cold-formed metal framing capable of withstanding design loads within limits and under conditions indicated.
   1. Design Loads: As indicated on Drawings.
   2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
      a. Exterior Non-Load-Bearing Framing, unless otherwise noted: Horizontal deflection of 1/360 of the wall height.
      b. Exterior Non-Load-Bearing Framing, supporting masonry veneer: Horizontal deflection of 1/600 of the wall height.
   3. Design framing systems to provide for movement of framing members without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.
   4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
      a. Upward and downward movement of 3/4 inch.
   5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.
   6. Building Frame Movement: Design, fabricate and install cold formed metal framing to withstand building movements including thermal movements, loading deflections, shrinkage, creep and similar movements. Thermal movements shall be as specified above. Building frame deflections, shrinkage, creep and other movements are available from the structural engineer.

C. Cold-Formed Steel Framing, General: Design according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions."
   1. Wall Studs: AISI S211.
   2. Headers: AISI S212.
   3. Lateral Design: AISI S213.

D. AISI Specifications and Standards: Unless more stringent requirements are indicated, comply with AISI S100 and AISI S200.

PART 2 PRODUCTS

2.1 COLD-FORMED STEEL FRAMING, GENERAL

A. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:
   1. Grade: As required by structural performance.
   2. Coating: G60.
      a. Use G90 as indicated for exterior exposed studs.

B. Steel Sheet for Vertical Deflection Clips: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:
   1. Grade: 50, Class 1 or 2.
   2. Coating: G90.

2.2 EXTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
   1. Minimum Base-Metal Thickness: 0.0428 inch.
   2. Flange Width: 1-5/8 inches.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
   1. Minimum Base-Metal Thickness: 0.0428 inch, but not less than stud thickness.
   2. Flange Width: 1-1/4 inches.

C. Vertical Deflection Clips: Manufacturer's standard bypass clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.

D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
   1. Minimum Base-Metal Thickness: 0.0428 inch (1.09 mm).
   2. Flange Width: 1 inch (25 mm) plus the design gap for one-story structures and 1 inch (25 mm) plus twice the design gap for other applications.

2.3 SOFFIT FRAMING

A. Exterior Soffit Frame: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:
   1. Minimum Base-Metal Thickness: 0.0428 inch (1.09 mm).
   2. Flange Width: 1-5/8 inches (41 mm), minimum.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
   1. Minimum Base-Metal Thickness: (0.84 mm)0.0428 inch (1.09 mm) (1.37 mm) (1.72 mm) (2.45 mm), but not less than stud thickness.
   2. Flange Width: 1-1/4 inches (32 mm).

2.4 INTERIOR SUSPENDED OVERHEAD FRAMING

A. Members: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:
   1. Minimum Base-Metal Thickness: 0.0329 inch.
   2. Flange Width: 1-5/8 inches, minimum.

2.5 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
   1. Supplementary framing.
   2. Bracing, bridging, and solid blocking.
   3. Web stiffeners.
   4. Anchor clips.
   5. End clips.
   6. Foundation clips.
   7. Stud kickers, knee braces, and girts.
   8. Hole reinforcing plates.
   9. Backer plates.

2.6 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.

B. Anchor Bolts: ASTM F 1554, Grade 36 threaded carbon-steel hex-headed bolts, and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153, Class C.

C. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

D. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E 1190 conducted by a qualified independent testing agency.

E. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.
   1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.

F. Welding Electrodes: Comply with AWS standards.

2.7 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: ASTM A 780.

2.8 FABRICATION

A. Fabricate cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
   1. Fabricate framing assemblies using jigs or templates.
   2. Cut framing members by sawing or shearing; do not torch cut.
   3. Fasten cold-formed metal framing members by screw fastening. Wire tying of framing members is not permitted.
      a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
      b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by no fewer than three exposed screw threads.
   4. Fasten other materials to cold-formed metal framing by screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.

C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
   1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
   2. Squareness: Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

3.3 INSTALLATION, GENERAL

A. Cold-formed metal framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed steel framing according to AISI S200 and to manufacturer's written instructions unless more stringent requirements are indicated.

C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
   1. Screw wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.

D. Install cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened.
   1. Cut framing members by sawing or shearing; do not torch cut.
   2. Fasten cold-formed metal framing members by screw fastening. Wire tying of framing members is not permitted.
      a. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.
      b. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

G. Do not bridge building expansion and control joints with cold-formed metal framing. Independently frame both sides of joints.

H. Install insulation, specified in Division 07 Section "Thermal Insulation," in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.

I. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's standard punched openings.

J. Erection Tolerances: Install cold-formed metal framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
   1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.4 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.

B. Fasten both flanges of studs to bottom track, unless otherwise indicated. Space studs as follows:
   1. Stud Spacing: 16 inches, maximum. Stud Spacing: (305 mm)16 inches (406 mm), maximum. Smaller spacings may be used to meet loading requirements. (488 mm).

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
   1. Connect vertical deflection clips to bypassing studs and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.
   1. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
   2. Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, fasteners, and stud girts, to provide a complete and stable wall-framing system.

3.5 FIELD QUALLY CONTROL

A. The Owner will engage an independent testing and inspection agency to verify the adequacy of the Contractor's quality control; refer to Section 01 40 00 "Quality Requirements." Before concealing the cold-formed metal framing work, obtain the required inspections of same from a representative of the Owner's independent testing and inspection agency.

B. Field and shop welds will be subject to testing and inspecting.

C. Special Inspector will report test results promptly and in writing to Contractor and Architect.

D. Cold-formed steel framing will be considered defective if it does not pass tests and inspections.

E. Remove and replace work that does not comply with specified requirements.

F. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.6 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed metal framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 054000

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal Planter Wall.
2. Boardwalk.

B. Related Requirements:

1. Refer to Structural Drawings and specifications for requirements for cast-in-place concrete walls.

1.2 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Fasteners.
2. Metal treatment and finishes.

B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:

1. Metal Planter Wall.
2. Boardwalk.

C. Samples for Verification: For each type and finish of metal.

1.4 INFORMATIONAL SUBMITTALS

A. Mill Certificates: Signed by stainless steel manufacturers, certifying that products furnished comply with requirements.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Research Reports: For post-installed anchors.

E. Delegated design engineer qualifications.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls, floor slabs, decks, and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 METAL PLANTER WALL

A. Basis of Design: Metal planters manufactured by Form and Fiber, Inc., Mabank, TX, 75147. (903) 603-9269 ext.1004; sales@formandfiber.com; www.formandfiber.com.

B. Provide Custom Metal Planters as indicated on the Drawings.

C. Planter Base Metal: Dark Bronze Powder Coated Steel, ASTM A606 Type 4 or ASTM A588 Steel.

D. Planter Dimensions: Refer to the Drawings for planter dimensions.

E. Base Metal Thickness: Refer to the Drawings for metal thickness.

F. Metal Planter Edge Condition: Refer to the Drawings for planter edge condition.

G. Factory-Applied Finish: Refer to the Finishing Article below.

2.3 BOARDWALK

A. Basis of Design: Wickcraft Boardwals, 2317 Daniels Street, Madison, WI 53718. Tel: (608) 244-9177 ; Website: https://www.wickcraftboardwalks.com/

B. Stainless Steel Bars and Shapes: ASTM A276/A276M, Type 316L.

C. Steel Tubing: ASTM A 500 or ASTM A 501, Grade B.

2.4 FASTENERS

A. General: Unless otherwise indicated, provide Type 316 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless steel fasteners for fastening stainless steel.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.

C. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 3, heavy-hex steel structural bolts; ASTM A563, Grade DH3, heavy-hex carbon-steel nuts; and where indicated, flat washers.

D. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563; and, where indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

2.5 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with Section 099113 "Exterior Painting."

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer that contains pigments that make it easily distinguishable from zinc-rich primer.

C. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.

D. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.6 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.7 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

1. Fabricate units from slotted channel framing where indicated.
2. Furnish inserts for units installed after concrete is placed.

2.8 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from stainless steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

2.9 GENERAL FINISH REQUIREMENTS

A. Finish metal fabrications after assembly.

B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.10 STEEL FINISHES

A. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

B. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:

1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
3. Items Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
4. Other Steel Items: SSPC-SP 3, "Power Tool Cleaning."

C. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.11 STAINLESS STEEL FINISHES

A. Shop prime stainless steel items unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

B. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:

1. Items Indicated to Receive Primers: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

C. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

D. Stainless Steel Preparation: SSPC-SP 6 blast of the stainless steel to clean the surface of grease, dust, dirt, mill scale, rust, or any other foreign matter and to create a 1.0-1.5mm anchor profile for receiving coating.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor shelf angles securely to existing construction with anchor bolts.

3.3 REPAIRS

A. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

    a. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

END OF SECTION 055000

SECTION 055000 - METAL FABRICATIONS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Steel framing and supports for mechanical and electrical equipment.
2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
3. Shelf angles.
4. Metal Stair Nosing.
5. Stainless steel and steel supports for fume extractors.
6. Steel framing posts for lead-lined doors.
7. Steel framing for oversized sliding door.

B. Products furnished, but not installed, under this Section include the following:
1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
3. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

C. Related Requirements:
1. Section 033000 "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.
2. Section 042000 "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.
3. Section 051200 "Structural Steel Framing."
4. Section 115313 “Laboratory Equipment and Appliances”.

1.3 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be

embedded in concrete or masonry. Deliver such items to Project site in time for installation.

C. Coordinate fabrication and installation with all adjacent ductwork, piping and conduit. Provide fully coordinated shop drawings.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Nonslip aggregates and nonslip-aggregate surface finishes.
   2. Paint products.
   3. Grout.

B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:
   1. Steel framing and supports for mechanical and electrical equipment.
   2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
   3. Shelf angles.
   4. Loose steel lintels.
   5. Metal Stair Nosing.
   6. Stainless steel and steel supports for fume extractors (Sheet A-432).
   7. Steel framing posts for lead-lined doors (Detail 3A/A-622).
   8. Steel framing for oversized sliding door (Detail 3B/A-622).

C. Samples for Verification: For each type and finish of extruded nosing.

D. Delegated-Design Submittal: For ladders, including analysis data signed and sealed by the qualified professional engineer licensed in the State of North Carolina and responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer.

B. Mill Certificates: Signed by stainless-steel manufacturers, certifying that products furnished comply with requirements.

C. Welding certificates.

D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.7 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer licensed in the State of North Carolina, as defined in Section 014000 "Quality Requirements," to design ladders.

B. Structural Performance of Aluminum Ladders: Aluminum ladders, including landings, shall withstand the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
   1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

C. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 304.

D. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.

E. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

F. Rolled-Stainless-Steel Floor Plate: ASTM A 793.

G. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.

H. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.

I. Zinc-Coated Steel Wire Rope: ASTM A 741.
   1. Wire-Rope Fittings: Hot-dip galvanized-steel connectors with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.

J. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
   1. Size of Channels: 1-5/8 by 1-5/8 inches.
   2. Material: Galvanized steel, ASTM A 653/A 653M, commercial steel, Type B, with G90 coating; 0.079-inch nominal thickness.
   3. Material: Cold-rolled steel, ASTM A 1008/A 1008M, commercial steel, Type B 0.0677-inch minimum thickness; coated with rust-inhibitive, baked-on, acrylic enamel.

K. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

L. Aluminum Plate and Sheet: ASTM B 209, Alloy 6061-T6.

M. Aluminum Extrusions: ASTM B 221, Alloy 6063-T6.

N. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T6.

O. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.

P. Bronze Extrusions: ASTM B 455, Alloy UNS No. C38500 (extruded architectural bronze).

Q. Bronze Castings: ASTM B 584, Alloy UNS No. C83600 (leaded red brass) or No. C84400 (leaded semired brass).

R. Nickel Silver Extrusions: ASTM B 151/B 151M, Alloy UNS No. C74500.

S. Nickel Silver Castings: ASTM B 584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
   1. Provide stainless-steel fasteners for fastening aluminum.
   2. Provide stainless-steel fasteners for fastening stainless steel.
   3. Provide stainless-steel fasteners for fastening nickel silver.
   4. Provide bronze fasteners for fastening bronze.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 325, Type 3; with hex nuts, ASTM A 563, Grade C3; and, where indicated, flat washers.

D. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F 593; with hex nuts, ASTM F 594; and, where indicated, flat washers; Alloy Group 1.

E. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.
   1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

F. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.

G. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.

H. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.
   1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.
   2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

I. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.

2.4 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with Section 099113 "Exterior Painting," Section 099123 Interior Painting," and Section 099600 "High-Performance Coatings."

B. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

C. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

D. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3000 psi.

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
   1. Fabricate units from slotted channel framing where indicated.
   2. Furnish inserts for units installed after concrete is placed.

C. Galvanize miscellaneous framing and supports where indicated.

D. Prime miscellaneous framing and supports with primer specified in Section 099600 "High-Performance Coatings" where indicated.

2.7 SHELF ANGLES

A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.
   1. Provide mitered and welded units at corners.
   2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches larger than expansion or control joint.

B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.

C. Galvanize and prime shelf angles located in exterior walls.

D. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.8 STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
   1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Galvanize exterior miscellaneous steel trim.

2.9 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

B. Galvanize plates.

2.10 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

B. Galvanize and prime loose steel lintels located in exterior walls.

2.11 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.12 FINISHES, GENERAL

A. Finish metal fabrications after assembly.

B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.13 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
   1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.

C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
   1. Shop prime with primers specified in Section 099113 "Exterior Painting" primers specified in Section 099123 "Interior Painting".

D. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:
   1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   3. Other Items: SSPC-SP 3, "Power Tool Cleaning."

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
   1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
   1. Cast Aluminum: Heavy coat of bituminous paint.
   2. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor supports for ceiling hung toilet partitions and overhead grilles securely to, and rigidly brace from, building structure.

C. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.
   1. Where grout space under bearing plates is indicated for girders supported on concrete or

masonry, install as specified in "Installing Bearing and Leveling Plates" Article.

D. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.
   1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.3 INSTALLING BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with nonshrink grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
   1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099113 "Exterior Painting" or Section 099123 "Interior Painting."

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 055000

SECTION 05 52 13 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Stainless-steel pipe and tube railings.

B. Related Requirements:
   1. Section 033000 "Cast-in-Place Concrete" for installing connection anchors in concrete.
   2. Section 034000 "Precast Architectural Concrete" for precast concrete.

1.3 COORDINATION

A. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

B. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

   1. Manufacturer's product lines of mechanically connected railings.
   2. Railing brackets.
   3. Grout, anchoring cement, and paint products.

B. IGCC Submittals
   1. Product data for IGCC Section 505.2.2: For steel having recycled content, documentation indicating percentages of pre-consumer and post-consumer recycled content. Include statement indicating cost of each product with recycled content.
   2. Product data for IGCC Section 505.2.3: For steel manufactured for recyclability, documentation indicating percentage of recyclability. Include statement indicating cost of each product with recyclable content.
   3. Recycled Content: Provide steel with minimum 25% recycled content and with minimum 30 percent recovery rate for recyclability.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

D. Samples: For each type of exposed finish required.

1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
2. Fittings and brackets.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Welding certificates.

C. Mill Certificates: Signed by manufacturers of stainless-steel products certifying that products furnished comply with requirements.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

1.8 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Stainless-Steel Pipe and Tube Railings:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
   a. Local stainless steel railing supplier

B. Source Limitations: Obtain each type of railing from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:

   a. Uniform load of 50 lbf/ ft. applied in any direction.

b. Concentrated load of 200 lbf applied in any direction.
c. Uniform and concentrated loads need not be assumed to act concurrently.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F.

2.3 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

1. Provide type of bracket with flange tapped for concealed anchorage to threaded hanger bolt and that provides 1-1/2-inch clearance from inside face of handrail to finished wall surface.

2.4 STAINLESS STEEL

A. Tubing: ASTM A 554, Grade MT 316 L.

B. Pipe: ASTM A 312/A 312M, Grade TP 316L

C. Plate and Sheet: ASTM A 240/A 240M or ASTM A 666, Type 316L.

2.5 FASTENERS

A. General: Provide the following:
1. Stainless-Steel Railings: Type 316L stainless-steel fasteners.
2. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.

C. Fasteners for Interconnecting Railing Components:

1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.
2. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.
3. Provide tamper-resistant flat-head machine screws for exposed fasteners unless otherwise indicated.

D. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to 6 times the load imposed when installed in unit masonry and 4 times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.
1. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 2 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

2.6 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

1. For stainless-steel railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

B. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

C. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
1. Water-Resistant Product: At exterior locations provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.7 FABRICATION

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections that are exposed to weather in a manner that excludes water. Provide weep holes where water may accumulate.

F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

G. Connections: Fabricate railings with welded connections unless otherwise indicated.

H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove flux immediately.
4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

I. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.

J. Form Changes in Direction as Follows:

1. As detailed.

K. Close exposed ends of railing members with prefabricated end fittings.

L. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.

M. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.

N. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

O. For railing posts set in concrete, provide steel sleeves not less than 6 inches long with inside dimensions not less than 1/2 inch greater than outside dimensions of post, with metal plate forming bottom closure.

P. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

2.8 STAINLESS-STEEL FINISHES

A. Remove tool and die marks and stretch lines, or blend into finish.

B. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches.

C. 180-Grit Polished Finish: Oil-ground, uniform, directionally textured finish.

D. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine concrete or pre-cast concrete assemblies, where reinforced to receive posts, to verify that locations of concealed reinforcements are clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

A. Fit exposed connections together to form tight, hairline joints.

B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

D. Adjust railings before anchoring to ensure matching alignment at abutting joints.

E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.

B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.

C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches of post.

3.4 ANCHORING POSTS

A. Use metal sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.

B. Leave anchorage joint exposed with anchoring material flush with adjacent surface.

3.5 ATTACHING RAILINGS

A. Anchor railing ends at walls with round flanges anchored to wall construction and welded to railing ends.

B. Attach railings to wall with wall brackets, except where end flanges are used. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

3.6 ADJUSTING AND CLEANING

A. Clean stainless steel by washing thoroughly with clean water and soap and rinsing with clean water.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A 780/A 780M.

3.7 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

END OF SECTION

SECTION 055213 - PIPE AND TUBE RAILINGS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Steel railings.

1.3 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

C. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

1.4 ACTION SUBMITTALS

A. Product Data:
   1. Manufacturer's product lines of mechanically connected railings.
   2. Railing brackets.
   3. Non-shrink, nonmetallic grout.
   4. Anchoring cement.
   5. Paint products.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Samples for Verification: For each type of exposed finish required.
   1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters, including finish.
   2. Fittings and brackets.

3. Assembled Sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Sample need not be full height.
   a. Show method of connecting and finishing members at intersections.

D. Delegated-Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

C. Product Test Reports: For tests on railings performed by a qualified testing agency, in accordance with ASTM E894 and ASTM E935.

D. Research Reports: For post-installed anchors, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect mechanical finishes on exposed surfaces of railings from damage by applying a strippable, temporary protective covering before shipping.

1.8 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design railings, including attachment to building construction.

B. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:
   a. Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
   b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
   c. Uniform and concentrated loads need not be assumed to act concurrently.
2. Infill of Guards:
   a. Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
   b. Infill load and other loads need not be assumed to act concurrently.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
   1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.
   1. Provide type of bracket with flange tapped for concealed anchorage to threaded hanger bolt that provides 1-1/2-inch (38-mm) clearance from inside face of handrail to finished wall surface.

2.3 STEEL RAILINGS

A. Pipe: ASTM A53/A53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.

B. Plates, Shapes, and Bars: ASTM A36/A36M.

2.4 FASTENERS

A. Fastener Materials:
   1. Ungalvanized-Steel Railing Components: Plated steel fasteners complying with ASTM F1941 (ASTM F1941M), Class Fe/Zn 5 for zinc coating.
   2. Hot-Dip Galvanized Railing Components: Type 304 stainless steel or hot-dip zinc-coated steel fasteners complying with ASTM A153/A153M or ASTM F2329/F2329M for zinc coating.
   3. Finish exposed fasteners to match appearance, including color and texture, of railings.

B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction and capable of withstanding design loads.

C. Fasteners for Interconnecting Railing Components:
   1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.

D. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 or ICC-ES AC308.
   1. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.

2.5 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for metal alloy welded.

B. Etching Cleaner for Galvanized Metal: Complying with MPI#25.

C. Galvanizing Repair Paint: High-zinc-dust-content paint, complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

D. Shop Primers: Provide primers that comply with Section 099113 "Exterior Painting"."

E. Intermediate Coats and Topcoats: Provide products that comply with Section 099113 "Exterior Painting."

F. Non-shrink, Nonmetallic Grout: Factory-packaged, non-staining, noncorrosive, nongaseous grout, complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

G. Anchoring Cement: Factory-packaged, non-shrink, non-staining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.

2.6 FABRICATION

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations.
   1. Clearly mark units for reassembly and coordinated installation.
   2. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately.
   1. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated.
   2. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections that are exposed to weather in a manner that excludes water.
   1. Provide weep holes where water may accumulate.
   2. Locate weep holes in inconspicuous locations.

F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

G. Connections: Fabricate railings with welded connections unless otherwise indicated.

H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove flux immediately.
   4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

I. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
   1. Fabricate splice joints for field connection, using an epoxy structural adhesive, if this is manufacturer's standard splicing method.

J. Form changes in direction as follows:
   1. By bending or by inserting prefabricated elbow fittings.

K. Bend members in jigs to produce uniform curvature for each configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

L. Close exposed ends of hollow railing members with prefabricated cap and end fittings of same metal and finish as railings.

M. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch (6 mm) or less.

N. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
   1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.

O. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work.

1. Fabricate anchorage devices capable of withstanding loads imposed by railings.
2. Coordinate anchorage devices with supporting structure.

P. For railing posts set in concrete, provide stainless steel sleeves not less than 6 inches (150 mm) long with inside dimensions not less than 1/2 inch (13 mm) greater than outside dimensions of post, with metal plate forming bottom closure.

Q. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

2.7 STEEL AND IRON FINISHES

A. Galvanized Railings:
1. Hot-dip galvanize steel railings, including hardware, after fabrication.
2. Comply with ASTM A123/A123M for hot-dip galvanized railings.
3. Comply with ASTM A153/A153M for hot-dip galvanized hardware.
4. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.

C. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner and as follows.
1. Comply with SSPC-SP 16.
2. Railings Indicated To Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3.
3. Other Railings: SSPC-SP 3.

D. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1 for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.
1. Shop prime uncoated railings with primers specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" unless otherwise indicated.

E. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1 for shop painting. Apply at spreading rates recommended by coating manufacturer.
1. Color: As selected by Architect from manufacturer's full range.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements are clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

A. Perform cutting, drilling, and fitting required for installing railings.
   1. Fit exposed connections together to form tight, hairline joints.
   2. Install railings level, plumb, square, true to line; without distortion, warp, or rack.
   3. Set railings accurately in location, alignment, and elevation; measured from established lines and levels.
   4. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
   5. Set posts plumb within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).
   6. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet (6 mm in 3.5 m).

B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
   1. Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

C. Adjust railings before anchoring to ensure matching alignment at abutting joints.

D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws, using plastic cement filler colored to match finish of railings.

B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article, whether welding is performed in the shop or in the field.

C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve, extending 2 inches (50 mm) beyond joint on either side; fasten internal sleeve securely to one side; and locate joint within 6 inches (150 mm) of post.

3.4 ANCHORING POSTS

A. Use stainless steel pipe sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions.

B. Leave anchorage joint exposed with 1/8-inch (3-mm) buildup, sloped away from post anchoring material flush with adjacent surface.

C. Anchor posts to metal surfaces with flanges, angle type, or floor type, as required by conditions, connected to posts and to metal supporting members as follows:
   1. For steel railings, weld flanges to post and bolt to metal supporting surfaces.

3.5 ATTACHING RAILINGS

A. Secure wall brackets and railing end flanges to building construction as follows:
   1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
   2. For hollow masonry anchorage, use toggle bolts.

3.6 REPAIR

A. Touchup Painting:
   1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
      a. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099113 "Exterior Painting."

3.7 CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A780/A780M.

3.8 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Final Acceptance.

B. Restore finishes damaged during installation and construction period, so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 055213

SECTION 057313 - GLAZED DECORATIVE METAL RAILINGS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Interior post-supported railings with glass-infill panels.

1.3 DEFINITIONS

A. Railings: Guards, handrails, and similar devices used for protection of occupants at open-sided floor and exterior deck areas and for pedestrian guidance and support, visual separation, or wall protection.

1.4 COORDINATION AND SCHEDULING

A. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver items to Project site in time for installation.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

A. Product Data:
   1. Metal railings assembled from standard components.
   2. Glass products.
   3. Fasteners.

B. Shop Drawings: Include plans, elevations, sections, and attachment details.

C. Samples for Initial Selection: For products involving selection of color, texture, or design, including mechanical finishes.

D. Samples for Verification: For each type of exposed finish required.
   1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
   2. Base channel.
   3. Each type of glass and glass edge required.
   4. Fittings and brackets.
   5. Assembled Samples of railing systems, made from full-size components, including top rail, post, handrail, glass-infill panels. Show method of finishing members at intersections. Samples need not be full height.

E. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer.

B. Product Test Reports: For tests performed by a qualified testing agency, in accordance with ASTM E894, ASTM E935, ASTM E2353, and ASTM E2358.

C. Evaluation Reports: From ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.
   1. For glazed decorative metal railings.
   2. For post-installed anchors.

1.8 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
   1. Build mockups for each form and finish of glass-infill panel railing consisting of two posts, top rail, handrail, glass-infill panel, and anchorage system components that are full height and are not less than 24 inches (600 mm) in length.
   2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.10 WARRANTY

A. Manufacturer's Special Warranty for Laminated Glass: Glazed decorative metal railing manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 GLAZED DECORATIVE RAILING (GR-1)

A. Manufacturers: Subject to compliance with requirements, provide Basis of Design product or comparable product indicated on drawings.

B. Source Limitations for Laminated Glass: Obtain from single source from single manufacturer.

C. Source Limitations for Decorative Metal Railing Components: Obtain from single source from single manufacturer for each component and installation method.

D. Product Options: Information on Drawings and in the Specifications establishes requirements for railing system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
   1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design glazed decorative metal railings, including attachment to building construction.

B. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
   1. Stainless Steel: 60 percent of minimum yield strength.

C. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
   1. Handrails and Top Rails of Guards:
      a. Uniform load of 50 lbf/ft. (0.73 kN/m) applied in any direction.
      b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
      c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Glass-Infill Panels:
   a. Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
   b. Infill load and other loads need not be assumed to act concurrently.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
   1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.3 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Same metal and finish as supported rails unless otherwise indicated.

2.4 STAINLESS STEEL

A. Tubing: ASTM A554, Grade MT 304.

B. Pipe: ASTM A312/A312M, Grade TP 304.

C. Castings: ASTM A743/A743M, Grade CF 8 or Grade CF 20.

D. Sheet, Strip, Plate, and Flat Bar: ASTM A666 or ASTM A240/A240M, Type 304.

E. Bars and Shapes: ASTM A276, Type 304.

2.5 GLASS AND GLAZING PRODUCTS, GENERAL

A. Glazing Publications: Comply with written instructions of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
   1. NGA/GANA Publications: "GANA Laminated Glazing Reference Manual" and "GANA Glazing Manual."

B. Safety Glazing: Glazing shall comply with 16 CFR 1201, Category II.

C. Safety Glazing Labeling: Permanently mark glass with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

D. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear), Class 1 and low-iron clear, or Class 2

(tinted) as indicated, Quality-Q3.

E. Glazing Gaskets for Glass-Infill Panels: Glazing gaskets and related accessories as recommended or supplied by railing manufacturer for installing glass-infill panels in post-supported railings.

2.6 GLASS HANDRAILS AND GUARDS

A. Tempered Glass Handrails and Guards: Provide products that have been tested for surface and edge compression in accordance with ASTM C1048 and for impact strength in accordance with 16 CFR 1201 for Category II materials.
   1. Glass Color: Clear.
   2. Thickness for Glass-Infill Panels: As required by structural loads, but not less than 6.0 mm.

B. Laminated Glass Handrails and Guards: ASTM C1172, Type II with two plies of glass bonded together by an interlayer.
   1. Construction: Laminate glass with polyvinyl butyral interlayer to comply with interlayer manufacturer's written instructions.
   2. Interlayer Thickness: 0.060 inch (1.52 mm) 0.090 inch (2.29 mm).
   3. Kind: LT (laminated tempered).
   4. Glass Color: Inner-ply clear; outer-ply clear.
   5. Interlayer Color: Clear.
   6. Glass Plies for Glass-Infill Panels: Thickness required by structural loads, but not less than 3.0 mm each.

2.7 FASTENERS

A. Fastener Materials: Unless otherwise indicated, provide the following:
   1. Stainless Steel Components: Type 304 stainless steel fasteners.
   2. Dissimilar Metals: Type 304 stainless steel fasteners.

B. Fasteners for Anchoring to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.

C. Provide concealed fasteners for interconnecting railing components and for attaching railings to other work unless exposed fasteners are the standard fastening method for railings indicated.
   1. Provide square or hex socket flat-head machine screws for exposed fasteners unless otherwise indicated.

D. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to design load, in accordance with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 or ICC-ES AC308.
   1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/ASTM F1941M, Class Fe/Zn 5, unless otherwise indicated.

2.8 MISCELLANEOUS MATERIALS

A. Embedded Mounted Shoe Base (057313.A): Aluminum alloy embedded shoe by TBK Metal or similar.

2.9 FABRICATION OF METAL RAILINGS

A. Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

F. Mechanical Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
   1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.

G. Form changes in direction as follows:
   1. By bending or by inserting prefabricated elbow fittings.

H. Close exposed ends of hollow railing members with prefabricated end fittings.

I. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, handrail brackets, miscellaneous fittings, and anchors to interconnect railing members to other work where indicated.
   1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers, or other means to transfer loads through wall finishes to structural supports and to prevent bracket or fitting rotation and crushing of substrate.

J. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

2.10 FABRICATION OF GLASS PANELS AND BALUSTERS

A. Fabricate glass to sizes and shapes required; provide for proper edge clearance and bite on glazing panels.

B. Glass-Infill Panels: Provide tempered laminated, tempered glass-infill panels.
   1. Edge Finish: Clean-cut or flat-grind edges to produce smooth, square edges with slight chamfers at junctions of edges and faces.

2.11 METAL FINISH REQUIREMENTS, GENERAL

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.12 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
   1. Run grain of directional finishes with long dimension of each piece.
   2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
   3. Brass Finish - Architect to select from manufacturer’s full range.

C. Stainless Steel Tubing Finishes:
   1. 180-Grit Polished Finish: Uniform, directionally textured finish.

D. Stainless Steel Sheet, Strip, Plate, and Bar Finishes:
   1. Directional Satin Finish: ASTM A480/A480M, No. 4.

PART 3 EXECUTION

3.1 INSTALLATION, GENERAL

A. Comply with Drawings and manufacturer's written instructions for installing glazed decorative metal railings, accessories, and other components.

B. Perform cutting, drilling, and fitting required for installing metal railings.
   1. Fit exposed connections together to form tight, hairline joints.
   2. Install railings level, plumb, square, true to line; without distortion, warp, or rack.
   3. Set railings accurately in location, alignment, and elevation; measured from established lines and levels.
   4. Do not weld, cut, or abrade surfaces of metal railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
   5. Set posts plumb within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).
   6. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet (5 mm in 3 m).

C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
   1. Coat concealed surfaces that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with bituminous paint.

D. Adjust railings before anchoring to ensure matching alignment at abutting joints.

E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.2 METAL RAILING CONNECTIONS

A. Nonwelded Connections:
   1. Use mechanical or adhesive joints for permanently connecting railing components.
   2. Use wood blocks and padding to prevent damage to railing members and fittings.
   3. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.

3.3 METAL ANCHORING POSTS

A. Anchor posts to metal surfaces with flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:
   1. For stainless steel railings, weld flanges to posts and bolt to metal-supporting surfaces.

3.4 INSTALLATION OF GLASS BALUSTERS

A. Post-Supported Railings with Glass-Infill Panels:
   1. Install assembly to comply with railing manufacturer's written instructions and with requirements in other Part 3 articles.
   2. Erect posts and other metal railing components, and set factory-cut glass-infill panels.
   3. Do not cut, drill, or alter glass-infill panels in field. Protect edges from damage.

3.5 FIELD QUALITY CONTROL

A. Extent and Testing Methodology: Testing agency will randomly select completed railing assemblies for testing that are representative of different railing designs and conditions in the completed Work. Test railings in accordance with ASTM E894, ASTM E935, ASTM E2353, and ASTM E2358 for compliance with performance requirements.

B. Remove and replace railings where test results indicate that they do not comply with specified requirements unless they can be repaired in a manner satisfactory to Architect and comply with specified requirements.

C. Perform additional testing and inspecting, at Contractor's expense, to determine compliance of replaced or additional work with specified requirements.

3.6 CLEANING

A. Clean aluminum and stainless steel by washing thoroughly with water and soap, rinsing with clean water, and wiping dry.

B. Clean and polish glass as recommended in writing by manufacturer. Wash both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion.

3.7 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 057313

SECTION 057500 - DECORATIVE FORMED METAL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Exterior fabrications made of formed metal sheet, secondary supports, and anchors to structure, including:
   1. Factory fabricated column covers.

1.2 RELATED REQUIREMENTS

A. Section 074113 - Metal Roof Panels: Formed metal for roofing applications.

B. Section 074213.23 - Metal Composite Material Wall Panels: Exterior wall panels of metal composite material.

C. Section 076200 - Sheet Metal Flashing and Trim: Formed metal flashings and trim.

D. Section 079200 - Joint Sealants.

1.3 REFERENCE STANDARDS

A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.

B. ASTM A449 - Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use; 2014 (Reapproved 2020).

C. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.

D. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); 2014.

E. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.

F. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2023).

G. AWS D1.6/D1.6M - Structural Welding Code - Stainless Steel; 2017, with Amendment (2021).

H. NAAMM AMP 500-06 - Metal Finishes Manual; 2006.

1.4 SUBMITTALS

A. Product Data - Sheet Metal Material: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.
   4. Specimen warranty.

B. Shop Drawings: Show layout and elevations, dimensions and thickness of panels, connections, details and location of joints, sealants and gaskets, method of anchorage, number of anchors, supports, reinforcement, trim, flashings, and accessories.
   1. Differentiate between shop and field fabrication.
   2. Indicate substrates and adjacent work with which the fabrications must be coordinated.
   3. Include large-scale details of anchorages and connecting elements.
   4. Include large-scale details or schematic, exploded or isometric diagrams to fully explain flashing at a scale of not less than _____ inches per _____ inches.

C. Verification Samples: For each finish product specified, minimum size 12 inches square, representing actual product in color and texture.

D. Installer’s Qualification Statement.

E. Maintenance Data: Care of finishes and warranty requirements.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing work of the type specified in this section.

B. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1/D1.1M and AWS D1.6/D1.6M no more than 12 months before start of scheduled welding work.

C. Mock-Up: Provide a mock-up for evaluation of fabrication workmanship.
   1. Locate where directed.
   2. Provide products finished as specified.
   3. Mock-up may remain as part of the Work.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in manufacturer's original, unopened, undamaged containers with identification labels intact.
   1. Protect finishes by applying heavy duty removable plastic film during production.
   2. Package for protection against transportation damage.
   3. Provide markings to identify components consistently with drawings.
   4. Exercise care in unloading, storing and installing panels to prevent bending, warping, twisting and surface damage.

B. Store products protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.
   1. Store in well-ventilated space out of direct sunlight.
   2. Protect from moisture and condensation with tarpaulins or other suitable weathertight covering installed to provide ventilation.
   3. Store at a slope to ensure positive drainage of accumulated water.
   4. Do not store in enclosed space where ambient temperature can exceed 120 degrees F.
   5. Avoid contact with other materials that might cause staining, denting, or other surface damage.

1.7 WARRANTY

A. See Section 017700 - Closeout Procedures, for additional warranty requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Factory Fabricated Column Covers:
   1. Basis of Design: Subject to compliance with requirements, provide PAC-CLAD PAC 1000F manufactured by an Pac-Clad Peterson; or comparable product by one of the following:
      a. AmeriClad.
      b. Moz.

2.2 FORMED METAL FABRICATIONS - GENERAL

A. Shop Assembly: Preassemble items to greatest extent possible. Minimize field splices and field assembly. Disassemble only as necessary for transportation and handling. Mark items clearly for assembly and installation.

B. Coordination: Match dimensions and attachment of formed metal items to adjacent construction. Produce integrated assemblies. Closely fit joints; align edges and flat surfaces unless indicated otherwise.

C. Forming: Profiles indicated. Maximize lengths. Fold exposed edges to form hem indicated or ease edges to radius indicated with concealed stiffener. Provide flat, flush surfaces without cracking or grain separation at bends.

D. Reinforcement: Increase metal thickness; use concealed stiffeners, backing materials or both. Provide stretcher leveled standard of flatness and stiffness required to maintain flatness and hold adjacent items in flush alignment.

E. Anchors: Straps, plates and anchors as required to support and anchor items to adjacent construction.

F. Supports: Miscellaneous framing, mounting, clips, sleeves, fasteners and accessories required

for installation.

G. Welding and Brazing: Weld or braze joints continuously. Grind, fill or dress to produce smooth, flush, exposed surfaces. Do not discolor metal. Grind smooth, polish, and restore damaged finishes to required condition.

H. Performance Requirements:
1. Thermal Movements:
a. Allow for thermal movements in exterior metal fabrications due to temperature changes. Prevent buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
b. Temperature Change Range: 120 degrees F, ambient; 180 degrees F, on material surfaces.
2. Corrosion: Prevent galvanic action and other forms of corrosion by isolating metals and other materials from direct contact with incompatible materials.

2.3 FACTORY FABRICATED COLUMN COVERS

A. Factory Fabricated Column Covers: Factory fabricated and factory finished, sheet metal column covers, mechanically fastened to structural support.
1. Material: Aluminum sheet, ASTM B209/B209M alloy 3003 or 5005.
2. Sheet Thickness: 0.125 inch, minimum.
3. Column Section Length: As shown on Drawings.
4. Fasteners: Manufacturer's standard.
5. Aluminum Finish: Manufacturer's standard factory applied PVDF coating.
6. Color: To be selected by Architect from manufacturer's full range to match adjacent structural columns.

2.4 MATERIALS

A. General: Provide sheet metal without pitting, seam marks, roller marks, stains, discolorations, or other imperfections exposed to view on finished units.

B. Aluminum Sheet: ASTM B209/B209M, 5005-H32 minimum; alloy and temper recommended by aluminum producer and finisher for use and finish indicated.

C. Fasteners, General: Same basic metal and alloy as formed metal sheet unless indicated otherwise. Do not use metals incompatible with the materials joined.

2.5 FINISHES

A. Finishes, General: Comply with NAAMM AMP 500-06.
1. Complete mechanical finishes before fabrication. After fabrication, finish joints, bends, abrasions and surface blemishes to match sheet.
2. Protect mechanical finishes on exposed surfaces from damage.
3. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.

4. Appearance: Limit variations in appearance of adjacent pieces to one-half of range represented in approved samples. Noticeable variations in same piece are not acceptable. Install components within range of approved samples to minimize contrast.

B. Aluminum Finishes:
1. Superior Performing Organic Coatings: AAMA 2605 multiple coat, thermally cured polyvinylidene fluoride system.
2. Color: To be selected by Architect from manufacturer's standard range.
3. Touch-Up Materials: As recommended by coating manufacturer for field application.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify dimensions, tolerances, and interfaces with other work.

B. Verify substrate on-site to determine that conditions are acceptable for product installation in accordance with manufacturer's written instructions.

C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

D. Notify Architect in writing of conditions detrimental to proper and timely completion of work. Do not proceed with erection until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect adjacent work areas and finish surfaces from damage during installation.

3.3 INSTALLATION - SHEET METAL AND PLATE FABRICATIONS

A. Locate and place decorative formed sheet metal items level and plumb; align with adjacent construction. Cut, drill and fit as required to install.

B. Do not cut or abrade sheet metal finishes that cannot be completely restored in the field. Return such items to manufacturer or fabricator for required alterations and refinishing or provide new items.

C. Use concealed anchorages where possible. Provide washers where needed on bolts or screws to protect metal surfaces and make weathertight connection.

D. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers indicated.

E. Corrosion Protection: Apply permanent separation materials on concealed surfaces where metals would otherwise be in direct contact with incompatible substrate materials. Prevent corrosion damage to material and finish.

3.4 CLEANING

A. Restore finishes damaged during installation and construction period. Return items that cannot be refinished in the field to manufacturer or fabricator. Refinish entire unit or provide new units.

B. Remove protective film after installation of joint sealers, after cleaning of adjacent materials, and immediately prior to completion of work.

C. Remove temporary coverings and protection of adjacent work areas.

D. Clean installed products in accordance with manufacturer's instructions.

3.5 PROTECTION

A. Protect installed products from damage during construction.

END OF SECTION 057500

SECTION 061000 - ROUGH CARPENTRY

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Blocking and nailers for rooftop equipment bases and support curbs.
   2. Wood blocking, cants, and nailers.
   3. Plywood backing panels.

1.3 DEFINITIONS

A. Boards or Strips: Lumber of less than 2 inches nominal size in least dimension.

B. Dimension Lumber: Lumber of 2 inches nominal size or greater but less than 5 inches nominal size in least dimension.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
   1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
   2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
   3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
   4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

B. Fastener Patterns: Full-size templates for fasteners in exposed framing.

1.5 INFORMATIONAL SUBMITTALS

A. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.

B. Evaluation Reports: For the following, from ICC-ES:
   1. Wood-preservative-treated wood.
   2. Fire-retardant-treated wood.
   3. Power-driven fasteners.
   4. Metal framing anchors.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Stack wood products flat with spacers beneath and between each bundle to provide air circulation. Protect wood products from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
   1. Factory mark each piece of lumber with grade stamp of grading agency.
   2. Dress lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content of Lumber: 19 percent unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.
   1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. Application: Treat items indicated on Drawings, and the following:
   1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
   2. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
   3. Wood framing members that are less than 18 inches above the ground in crawlspaces or unexcavated areas.
   4. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
   1. Treatment shall not promote corrosion of metal fasteners.
   2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
   3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
   4. Design Value Adjustment Factors: Treated lumber shall be tested according to ASTM D 5664 and design value adjustment factors shall be calculated according to ASTM D 6841. For enclosed roof framing, framing in attic spaces, and where high temperature fire-retardant treatment is indicated, provide material with adjustment factors of not less than 0.85 modulus of elasticity and 0.75 for extreme fiber in bending for Project's climatological zone.

C. Kiln-dry lumber after treatment to maximum moisture content of 19 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.

E. For exposed items indicated to receive a stained or natural finish, chemical formulations shall not bleed through, contain colorants, or otherwise adversely affect finishes.

F. Application: Treat all rough carpentry unless otherwise indicated.

2.4 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
   1. Blocking.
   2. Nailers.
   3. Rooftop equipment bases and support curbs.
   4. Cants.

B. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

C. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

2.5 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: Plywood, DOC PS 1, Exterior, A-C, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

2.6 FASTENERS

A. General: Fasteners shall be of size and type indicated and shall comply with requirements specified in this article for material and manufacture.
   1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M or Type 304 stainless steel.

B. Nails, Brads, and Staples: ASTM F 1667.
   1. Screws for Fastening to Metal Framing: (Steel Stud) ASTM C 1002 or (CFMF) ASTM C 954, length as recommended by screw manufacturer for material being fastened.

2.7 METAL FRAMING ANCHORS

A. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 coating designation.
   1. Use for interior locations unless otherwise indicated.

B. Hot-Dip, Heavy-Galvanized Steel Sheet: ASTM A 653/A 653M; structural steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 coating designation; and not less than 0.036 inch thick.
   1. Use for wood-preservative-treated lumber and where indicated.

C. Stainless-Steel Sheet: ASTM A 666, Type 304.
   1. Use for exterior locations and where indicated.

2.8 MISCELLANEOUS MATERIALS

A. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch. Insure compatibility with adjacent materials.

PART 3 EXECUTION

3.1 INSTALLATION, GENERAL

A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

B. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate furring, nailers, blocking, and similar supports to comply with requirements for attaching other construction.

C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.

D. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.

E. Do not splice structural members between supports unless otherwise indicated.

F. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
   1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.

G. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
   1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
   2. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal thickness.
   3. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 sq. ft. and to solidly fill space below partitions.

4. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 feet o.c.

H. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

I. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
1. Use inorganic boron for items that are continuously protected from liquid water.
2. Use copper naphthenate for items not continuously protected from liquid water.

J. Where wood-preservative-treated lumber is installed adjacent to metal framing or metal decking, install continuous flexible flashing separator between wood and metal decking.

K. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code (IBC).
2. ICC-ES evaluation report for fastener.

L. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 WOOD BLOCKING, AND NAILER INSTALLATION

A. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.3 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

B. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061000

SECTION 061533 - WOOD PATIO DECKING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wood decking

B. Related Requirements:

1. Section 055000 "Metal Fabrication" for metal frame.

1.2 DEFINITIONS

A. Boards: Lumber of less than 2 inches nominal in thickness and 2 inches nominal or greater in width.

B. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.

C. Timber: Lumber of 5 inches nominal or greater in least dimension.

D. Lumber grading agencies, and the abbreviations used to reference them, include the following:

1. NeLMA: Northeastern Lumber Manufacturers' Association.
2. NLGA: National Lumber Grades Authority.
3. SPIB: The Southern Pine Inspection Bureau.

1.3 ACTION SUBMITTALS

A. Product Data: For preservative-treated wood products and metal framing anchors.

1. For preservative-treated wood products. Include chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.
2. For metal framing anchors. Include installation instructions.
3. For anti-slip decking treatment.

B. Samples: For plastic decking, not less than 24 inches long, showing the range of variation to be expected in appearance of decking, including surface texture and anti-slip treatment.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates:

1. For lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by ALSC's Board of Review.
2. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

B. Certificates of Inspection: Issued by lumber grading agency for exposed wood products not marked with grade stamp.

C. Evaluation Reports: For the following, from ICC-ES:

1. Preservative-treated wood products
2. Expansion anchors.
3. Metal framing anchors.
4. Decking fasteners
5. Certifies slip-resistance values for proposed material in wet and dry conditions

1.5 QUALITY ASSURANCE

A. Lumber Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

B. Installer qualification: Minimum 5 years of experience installing exterior decking with slip-resistant treatment.

C. Mock-up: Provide minimum 6’x6’ installed section showing material, finish, and anti-slip treatment for review.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials under cover and protected from weather and contact with damp or wet surfaces. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 LUMBER, GENERAL

A. Comply with DOC PS 20 and with grading rules of lumber grading agencies certified by ALSC's Board of Review as applicable. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by ALSC's Board of Review.

1. Factory mark each item with grade stamp of grading agency.
2. For items that are exposed to view in the completed Work, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry wood products.
4. Provide dressed lumber, S4S, unless otherwise indicated.
5. All lumber to be kiln dried

B. Maximum Moisture Content:

1. Boards: 15 percent.
2. Dimension Lumber: 15 percent for 2-inch nominal thickness or less; 19 percent for more than 2-inch nominal thickness.
3. Timber: 19 percent

2.2 WOOD DECKING

A. Hand select wood for freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot holes, shake, splits, torn grain, and wane.

Board Decking: 1-1/4-inch actual thickness by 6 inch width radius-edged S4S boards, with one face free of planer skip, machine burn, and torn or chipped grain. Pre-grooved on two edges to receive hidden fasteners.

1. Type: Thermally modified ash
2. Grade Characteristics:

    a. Clear.
    b. Grade A
    c. Sound.
    d. Straight grained and parallel cut, no quarter sawn surfaces.
    e. No decay, incipient decay, honeycomb, knot holes, shakes, splits, or wane.
    f. No discoloration
    g. Finish: Per manufacturer’s recommendation.

B. Slip-resistant Treatment
1. Anti-slip coating:
    a. Type: Water-based or solvent-based coating with embedded grit (aluminum oxide or silica)
    b. VOC-compliant; UV- and weather-resistant.
    c. Color: Clear.
2. Surface insert:
    a. Type: Fiberglass, aluminum, or resin strips with mineral abrasive.
    b. Location: Factory-installed or field-installed on top face of decking.
    c. Fastening: Adhesive and mechanical, flush to surface.

2.3 DIMENSION LUMBER FRAMING

A. Deck Framing: No. 1 grade or better and of the following species:
   1. Southern pine; SPIB.

B. Deck Framing: Any species and grade with a modulus of elasticity of at least 1,500,000 psi and an extreme fiber stress in bending of at least 1000 psi for 2-inch nominal thickness and 12-inch nominal width for single-member use.

2.4 PRESERVATIVE TREATMENT

A. Pressure treat boards and dimension lumber with waterborne preservative according to AWPA U1; Use Category UC3b.

B. Pressure treat timber with waterborne preservative according to AWPA U1; Use Category UC4a.

C. Preservative Chemicals: Acceptable to authorities having jurisdiction.

   1. Do not use chemicals containing arsenic or chromium.

D. Use process for boards and dimension lumber that includes water-repellent treatment.

E. Use process for boards and dimension lumber that does not include water repellents or other substances that might interfere with application of indicated finishes.

F. After treatment, re-dry boards to 19 percent maximum moisture content.

G. Mark treated wood with treatment quality mark of an inspection agency approved by ALSC's Board of Review.

H. Application: Treat all wood unless otherwise indicated.

   1. Framing members
   2. Members in contact with masonry or concrete
   3. Decking

2.5 FASTENERS

A. General: Provide fasteners of size and type indicated, acceptable to authorities having jurisdiction, and that comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than 1-1/2 inches into wood substrate.

   1. Use fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M or ASTM F 2329 unless otherwise indicated.
   2. For pressure-preservative-treated wood, use stainless-steel fasteners.
   3. For wood decking, use stainless-steel fasteners where fasteners are exposed to view.

B. Nails: ASTM F 1667.

C. Power-Driven Fasteners: ICC-ES AC70

D. Wood Screws and Lag Screws: ASME B18.2.1, ASME B18.6.1, or ICC-ES AC233

E. Stainless-Steel Bolts: ASTM F 593, Alloy Group 1 or 2; with ASTM F 594, Alloy Group 1 or 2 hex nuts and, where indicated, flat washers.

2.6 METAL FRAMING ANCHORS

A. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those indicated on Drawings. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

B. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G185 coating designation.

2.7 CONCEALED DECKING FASTENERS

A. Deck Splines: Corrosion-resistant metal or plastic splines that fit in grooves routed into the sides of decking material and are fastened to deck framing with screws. Splines provide uniform spacing of decking material.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Hidden stainless steel fasteners

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of projections and substances detrimental to application.

3.3 INSTALLATION, GENERAL

A. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit work to other construction; scribe and cope as needed for accurate fit.

B. Install anti-slip treatments per manufacturer’s specifications.

C. Ensure planks are fastened flush and surface is free of trip hazard.

D. Install slip-resistant inserts or strips in all designated areas, including ramps, stairs, and high-traffic zones.

E. Framing Standard: Comply with AF&PA WCD1 unless otherwise indicated.

F. Install wood decking with crown up (bark side down).

G. Secure decking to framing with stainless steel fasteners: pre-drill holes (deck splines as alternate).

H. Install metal framing anchors to comply with manufacturer's written instructions.

I. Do not splice structural members between supports unless otherwise indicated.

J. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

K. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of members or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

L. Securely attach exterior rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. ICC-ES AC70 for power-driven fasteners.
2. "Fastening Schedule" in ICC's International Building Code.

M. Use common wire nails unless otherwise indicated. Select fasteners of size that do not fully penetrate members where opposite side is exposed to view. Make tight connections between members. Install fasteners without splitting wood; do not countersink nail heads unless otherwise indicated.

3.4 ELEVATED DECK JOIST FRAMING INSTALLATION

A. General: Install joists with crown edge up and support ends of each member with not less than 1-1/2 inches of bearing on wood or metal, or 3 inches on masonry. Attach floor joists where framed into wood supporting members by using wood ledgers as indicated or, if not indicated, by using metal joist hangers. Do not notch joists.

B. Frame openings with headers and trimmers supported by metal joist hangers; double headers and trimmers where span of header exceeds 48 inches.

C. Lap members framing from opposite sides of beams or girders not less than 4 inches or securely tie opposing members together. Provide solid blocking of 2-inch nominal thickness by depth of joist over supports.

D. Provide solid blocking of 2-inch nominal thickness by depth of joist at intervals of 96 inches o.c., between joists.

3.5 CLEANING AND PROTECTION

A. Clean surface of dust, adhesives, and debris after installation.

B. Protect from heavy use until final acceptance.

C. Provide owner with maintenance instructions, including frequency of reapplication for coating if needed.

END OF SECTION 061533

SECTION 061600 - SHEATHING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Wall sheathing.
   2. Parapet sheathing.

B. Related Requirements:
   1. Section 061000 "Rough Carpentry" for plywood backing panels.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review air-barrier and water-resistant glass-mat gypsum sheathing requirements and installation, special details, transitions, mockups, air-leakage testing, protection, and work scheduling that covers air-barrier and water-resistant glass-mat gypsum sheathing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
   1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
   2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.
   3. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D5516.
   4. For products receiving waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
   5. For air-barrier and water-resistant glass-mat gypsum sheathing, include manufacturer's technical data and tested physical and performance properties of products.
   6. Submit product data on all treated wood products indicating manufacturer’s recommended galvanizing treatment for fasteners. Submittals shall be provided indicating

that all fasteners meet manufacturer’s recommendations.

B. Shop Drawings: For air-barrier and water-resistant glass-mat gypsum sheathing assemblies.
   1. Show locations and extent of sheathing, accessories, and assemblies specific to Project conditions.
   2. Include details for sheathing joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
   3. Include details of interfaces with other materials that form part of air barrier.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: From air-barrier and water-resistant glass-mat gypsum sheathing manufacturer, certifying compatibility of sheathing accessory materials with Project materials that connect to or that come in contact with the sheathing.

C. Product Test Reports: For each air-barrier and water-resistant glass-mat gypsum sheathing assembly, indicating compliance with specified requirements, for tests performed by a qualified testing agency.

D. Evaluation Reports: For the following, from ICC-ES:
   1. Wood-preservative-treated plywood.
   2. Fire-retardant-treated plywood.
   3. Foam-plastic sheathing.
   4. Air-barrier and water-resistant glass-mat gypsum sheathing.

E. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer of air-barrier and water-resistant glass-mat gypsum sheathing.
   1. Installer shall be licensed by ABAA according to ABAA's Quality Assurance Program and shall employ ABAA-certified installers and supervisors on Project.

B. Mockups: Build mockups to set quality standards for materials and execution and for preconstruction testing.
   1. Build integrated mockups of exterior wall assembly as indicated on Drawings, incorporating backup wall construction, window, storefront, door frame and sill, ties and other penetrations, and flashing to demonstrate crack and joint treatment and sealing of gaps, terminations, and penetrations of air-barrier sheathing assembly.
      a. Coordinate construction of mockups to permit inspection and testing of sheathing before external insulation and cladding are installed.
      b. Include junction with roofing membrane, building corner condition, and foundation wall intersection.
      c. If Architect determines mockups do not comply with requirements, reconstruct mockups until mockups are approved.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Final Acceptance.

C. Testing Agency Qualifications:
1. For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.
2. For testing and inspecting agency providing tests and inspections related to air-barrier and water-resistant glass-mat gypsum sheathing: an independent agency, qualified according to ASTM E329 for testing indicated, and certified by Air Barrier Association of America, Inc.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance Ratings: As tested according to ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 WOOD PANEL PRODUCTS

A. Emissions: Products shall meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.

C. Factory mark panels to indicate compliance with applicable standard.

2.3 FIRE-RETARDANT-TREATED PLYWOOD

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-

test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
   1. Use treatment that does not promote corrosion of metal fasteners.
   2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
   3. Design Value Adjustment Factors: Treated lumber plywood shall be tested according to ASTM D5516 and design value adjustment factors shall be calculated according to ASTM D6305. Span ratings after treatment shall be not less than span ratings specified.

C. Kiln-dry material after treatment to a maximum moisture content of 15 percent. Do not use material that is warped or does not comply with requirements for untreated material.

D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.

E. Application: Treat all plywood sheathing unless otherwise indicated.

2.4 WALL SHEATHING

A. Glass-Mat Gypsum Sheathing with Factory-Applied Air Barrier Membrane: ASTM C1177/C1177M.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
      a. CertainTeed Corporation.
      b. Continental Building Products, LLC.
      c. National Gypsum Company.
   2. Type and Thickness: Type X, 5/8 inch thick.
   3. Size: 48 by 120 inches for vertical installation.

2.5 PARAPET SHEATHING

A. Plywood Sheathing: Either DOC PS 1 or DOC PS 2, Exterior, Structural I sheathing.
   1. Type and Thickness: Fire-retardant-treated, 5/8 inch thick.
   2. Span rating: Not less than 16/0.

2.6 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
   1. For parapet and wall sheathing, provide fasteners.

B. Nails, Brads, and Staples: ASTM F1667.

C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Screws for Fastening Sheathing to Wood Framing: ASTM C1002.

E. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached.
   1. For steel framing less than 0.0329 inch thick, use screws that comply with ASTM C1002.
   2. For steel framing from 0.033 to 0.112 inch thick, use screws that comply with ASTM C954.

F. Screws for Fastening Composite Nail Base Insulated Roof Sheathing to Metal Roof Deck: Steel drill screws, in type and length recommended by sheathing manufacturer for thickness of sheathing to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B117. Provide washers or plates if recommended by sheathing manufacturer.

2.7 MISCELLANEOUS MATERIALS

A. Furnish auxiliary materials recommended by integrated sheathing and air barrier system manufacturer for intended use, with compatibility meeting ASTM E2357.

B. Self-adhering Transition Membrane for rough opening, window and door flashings and transitions. Comply with recommendations of manufacturer for integrated sheathing and air barrier system.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Tremco, Inc. product ExoAir® 110AT, or comparable product by one of the following:
      a. Carlisle Coatings and Waterproofing.
      b. Grace Construction Products.
      c. Henry, Co.
      d. W.R. Meadows, Inc.

C. Self-adhering Counterflashing to Metal Flashings. Comply with recommendations of manufacturer for integrated sheathing and air barrier system.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Tremco, Inc. product ExoAir® 110AT, or comparable product by one of the following:
      a. Carlisle Coatings and Waterproofing.
      b. Grace Construction Products.
      c. Henry Co.
      d. W.R. Meadows, Inc.

D. Flashing Primer: Material recommended by transition membrane manufacturer where required to prepare substrates to receive self-adhered flashing. Basis-of-design product is ExoAir primer by Tremco, Inc., or equal.

E. Insulation Primer: Material recommended by insulation manufacturer where required for adhesion of insulation to substrates.

PART 3 EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:
   1. Table 2304.9.1, "Fastening Schedule," in the ICC's International Building Code.
   2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in the ICC's International Residential Code for One- and Two-Family Dwellings.
   3. ICC-ES evaluation report for fastener.

D. Use common wire nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.

E. Coordinate wall and parapet sheathing installation with flashing and joint-sealant installation, so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 GYPSUM SHEATHING INSTALLATION

A. Comply with GA-253 and with manufacturer's written instructions.
   1. Fasten gypsum sheathing to wood framing with screws.
   2. Fasten gypsum sheathing to cold-formed metal framing with screws.
   3. Install panels with a 3/8-inch gap where non-load-bearing construction abuts structural elements.
   4. Install panels with a 1/4-inch gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.

B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.

C. Horizontal Installation: Install sheathing with V-grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent panels without forcing. Abut ends over centers of studs, and stagger end joints of adjacent panels not less than one stud spacing. Attach at perimeter and within field of panel to each stud.
   1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of panels.
   2. For sheathing under stucco cladding, panels may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.

D. Vertical Installation: Install vertical edges centered over studs. Abut ends and edges with those of adjacent panels. Attach at perimeter and within field of panel to each stud.
   1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of panels.
   2. For sheathing under stucco cladding, panels may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.

E. Seal sheathing joints according to sheathing manufacturer's written instructions.
   1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient amount of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.
   2. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing joints and apply and trowel sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.

3.3 FIELD QUALITY CONTROL

A. ABAA Quality Assurance Program: Perform examinations, preparation, installation, testing, and inspections under ABAA's Quality Assurance Program.

B. Testing and Inspecting Agency: Owner will engage a qualified testing agency to perform tests and inspections.

C. Inspections: Air-barrier and water-resistant glass-mat gypsum sheathing, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:
   1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
   2. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
   3. Termination mastic has been applied on cut edges.
   4. Strips and transition strips have been firmly adhered to substrate.
   5. Compatible materials have been used.
   6. Transitions at changes in direction and structural support at gaps have been provided.
   7. Connections between assemblies (sheathing and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support,

integrity, and continuity of seal.

8. All penetrations have been sealed.

D. Tests: As determined by testing agency from among the following tests:
   1. Air-Leakage-Location Testing: Air-barrier sheathing assemblies will be tested for evidence of air leakage according to ASTM E1186, chamber pressurization or depressurization with smoke tracers.
   2. Air-Leakage-Volume Testing: Air-barrier assemblies will be tested for air-leakage rate according to ASTM E783 or ASTM E2357.

E. Air barriers will be considered defective if they do not pass tests and inspections.

F. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

G. Prepare test and inspection reports.

END OF SECTION 061600

SECTION 061643 - GYPSUM SHEATHING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Wall sheathing.
   2. Sheathing penetration treatment.

1.2 RELATED REQUIREMENTS

A. Section 054000 - Cold-Formed Metal Framing.

B. Section 072500 - Weather Barriers.

1.3 SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1.4 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at Project site. Review requirements for flashing, including surface preparation specified under other Sections, substrate condition and any pretreatment, special details, installation procedures, inspections, protection and repairs.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

B. Deliver materials to Project site in original packages with seals unbroken, labeled with manufacturer's name, product brand name and type, and directions for storing.

C. Store liquid materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by flashing manufacturer.

D. Remove and replace liquid materials that cannot be applied within their stated shelf life.

E. Protect stored materials from direct sunlight.

1.6 WARRANTY

A. Material Warranty: Provide sheathing manufacturer's standard warranty covering sheathing material for five years commencing on date of purchase by Contractor.

B. Weathering Warranty: Provide sheathing manufacturer's standard warranty covering in-place exposure damage for six months commencing on date of purchase by Contractor.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For assemblies with fire-resistance ratings, provide materials and construction identical to those of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.
   1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory."

2.2 WALL SHEATHING

A. Glass-Mat Gypsum Wall Sheathing: ASTM C 1177/1177M.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. CertainTeed Corporation; GlasRoc.
      b. G-P Gypsum Corporation; Dens-Glass Gold.
      c. National Gypsum Co.; Gold Bond eXP.
      d. Temple-Inland Inc.; GreenGlass.
      e. United States Gypsum Co.; Securock.
   2. Types and Thickness:
      a. Type X, 5/8 inch thick for typical application, unless noted otherwise.
   3. Size: 48 by 96 inches or 48 by 108 inches or 48 by 120 inches for vertical installation.
   4. Soft-Body Impact: ASTM C1629/C1629M; Level 3.
   5. Hard-Body Impact: ASTM C1629/C1629M; Level 2.

2.3 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
   1. For wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Nails, Brads, and Staples: ASTM F 1667.

C. Power-Driven Fasteners: NES NER-272.

D. Screws for Fastening Gypsum Sheathing to Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.
   1. For steel framing less than 0.0329 inch thick, use screws that comply with ASTM C 1002.
   2. For steel framing from 0.033 to 0.112 inch thick, use screws that comply with ASTM C 954.

2.4 SHEATHING PENETRATION TREATMENT MATERIALS

A. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant complying with ASTM C 834, compatible with sheathing tape and sheathing and recommended by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.
   1. Sheathing Tape: Self-adhering glass-fiber tape, minimum 2 inches wide, 10 by 10 or 10 by 20 threads/inch, of type recommended by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing penetrations in glass-mat gypsum sheathing and with a history of successful in-service use.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine framing; verify that framing and furring members to receive sheathing do not vary more than 1/8 inch vertically and horizontally from outside face of adjacent members.

B. Ensure through-wall flashing indicated to be installed prior to installation of sheathing is properly anchored and of proper size.

3.2 WALL SHEATHING INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Coordinate location and installation of flashing which penetrates and is attached behind sheathing. Install portions of sheathing beneath flashing as shown on the Drawings.

C. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

D. Securely attach to substrate by fastening as indicated, complying with the following:
   1. NES NER-272 for power-driven fasteners.
   2. Table 2304.9.1, "Fastening Schedule," in ICC's "International Building Code."

E. Coordinate wall sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing

through completed assembly.

F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.3 GYPSUM SHEATHING INSTALLATION

A. Comply with GA-253 and with manufacturer's written instructions.
   1. Fasten gypsum sheathing to metal framing with screws.
   2. Install boards with a 3/8-inch gap where non-load-bearing construction abuts structural elements.
   3. Install boards with a 1/4-inch gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.

B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.

C. Vertical Installation: Install board vertical edges centered over studs; horizontal installation is not acceptable. Abut ends and edges of each board with those of adjacent boards. Attach boards at perimeter and within field of board to each stud.
   1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of boards.
   2. For sheathing under stucco cladding, boards may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.

D. Seal penetrations according to sheathing manufacturer's written instructions.

END OF SECTION 061643

SECTION 064100 - ARCHITECTURAL WOOD CASEWORK

PART 1 GENERAL

1.1 SUMMARY

A. Work Results:

B. Principal Products:

C. Section Includes:
1. Wood cabinets for transparent finish.
2. Wood cabinets for opaque finish.
3. Specialty fabricated cabinet units.
4. Hardware accessories.
5. Shop priming.
6. Shop finishing.

D. Related Requirements:
1. Section 061000 "Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing interior architectural woodwork that are concealed within other construction before interior architectural woodwork installation.
2. Section 062023 "Interior Finish Carpentry" for interior carpentry exposed to view that is not specified in this Section.

1.2 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections, to ensure that architectural wood casework can be supported and installed as indicated.

1.3 ACTION SUBMITTALS

A. Product Data Submittals: For each product.

B. Shop Drawings: For architectural cabinets.
1. Include the following:
   a. Dimensioned plans, elevations, and sections.
   b. Attachment details.
2. Show large-scale details.
3. Show locations and sizes of furring, blocking, and hanging strips, including blocking and reinforcement concealed by construction and specified in other Sections.
4. Apply AWI Quality Certification Program label to Shop Drawings.

C. Samples for Verification for the following:
   1. (1) Cabinet door or drawer front of each opaque finish with specified pull attached.
   2. (1) 12” x 12” finished hardwood unit of each transparent finish.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For architectural woodwork manufacturer and Installer.

B. Product Certificates: Manufacturer's Certification to verify materials comply with specified requirements and suitable for intended application.

C. Product data for each type of process, factory and non-factory fabricated product. Indicate component materials, dimensions, profiles, textures, colors and include construction and application details.

D. Provide manufacturer’s warranty.

1.5 CLOSEOUT SUBMITTALS

A. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

1.6 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
   1. Manufacturer's Certification: Licensed participant in AWI's Quality Certification Program.
   2. Installer Qualifications: Licensed participant in AWI's Quality Certification Program.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
   1. Build mockups of typical architectural wood casework as shown on Drawings in each volume.
   2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
   3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Comply with the Architectural Woodwork Standards, Section 2.

B. Do not deliver architectural wood casework until painting and similar finish operations that might damage casework have been completed in installation areas.

C. Store casework in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.8 FIELD CONDITIONS

A. Environmental Limitations with Humidity Control: Do not deliver or install interior architectural woodwork until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F (16 and 32 deg C) and relative humidity between 25 and 55 percent during the remainder of the construction period.

B. Field Measurements: Where architectural wood casework is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings.
   1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being concealed by construction, and indicate measurements on Shop Drawings.

PART 2 PRODUCTS

2.1 ARCHITECTURAL WOOD CASEWORK (AWC-)

A. All materials shall be furnished to the quality as specified in the construction drawings and in accordance with the Architect’s/Interior Design specifications. All wood plastics and composites qualities shall meet and/or exceed industry standards for the specified application. Concealed, exposed or semi-exposed surface finishes/species are to be per Architect or Interior Designer specifications/Finish Legends or approved recommendation by manufacturer.

2.2 WOODWORK, GENERAL

A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.
   1. Provide certificates from AWI certification program indicating that woodwork and installation complies with requirements of grades specified.

2.3 WOOD CABINETS FOR TRANSPARENT FINISH

A. Architectural Woodwork Standards Grade: Premium.

B. Type of Construction: Face frame.

C. Door Front Style: Flush Overlay.
   1. Reveal Dimension: 1/8 inch (3 mm).

D. Wood for Exposed Surfaces:
   1. Species: White Oak, stained to match Koroseal W5615CUM.
   2. Cut: Flat Cut.
   3. Grain Direction: Vertically for drawer fronts, doors, and fixed panels.
   4. Matching within Panel Face: Center-balance match.

E. Semiexposed Surfaces:
   1. Surfaces Other Than Drawer Bodies: Same species and cut indicated for exposed surfaces.

2.4 CABINET HARDWARE AND ACCESSORIES

A. Cabinet Hardware: Provide cabinet hardware and accessory materials associated with architectural cabinets except for items specified in Section 087100 "Door Hardware."
   1. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, B01602, 100 degrees of opening, self-closing where not located at accessible front-approach casework.
   2. Pulls: As indicated on Drawings.
   3. Catches: Magnetic catches, ANSI/BHMA A156.9, B03141.
   4. Adjustable Shelf Standards and Supports: ANSI/BHMA A156.9, B04071; with shelf rests, B04081.
   5. Shelf Rests: ANSI/BHMA A156.9, B04013; metal.

B. Grommets for Cable Passage: 1-1/4-inch (32-mm) OD, molded-plastic grommets and matching plastic caps with slot for wire passage.
   1. Color: Black.

C. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with ANSI/BHMA A156.18 for BHMA finish number indicated or as indicated on Drawings.
   1. Flat Black Coated: ANSI/BHMA 622 for Brass/Bronze base; ANSI/BHMA 676 for Aluminum base; ANSI/BHMA 693 for any base.

D. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in ANSI/BHMA A156.9.

2.5 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln-dried to less than 15 percent moisture content.

B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

2.6 FABRICATION

A. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before

fabrication.

B. Fabricate architectural cabinets to dimensions, profiles, and details indicated. Ease edges and corners to 1/16-inch (1.5-mm) radius unless otherwise indicated.

C. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
   1. Notify Architect seven days in advance of the dates and times architectural cabinet fabrication will be complete.

D. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

2.7 SHOP FINISHING

A. Finish architectural cabinets at manufacturer's shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.

B. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural cabinets, as applicable to each unit of work.
   1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of cabinets.

C. Transparent Finish:
   1. Architectural Woodwork Standards Grade: Premium.
   2. Finish: System - 5, conversion varnish.
   3. Wash Coat for Closed-Grain Woods: Apply wash-coat sealer to cabinets made from closed-grain wood before staining and finishing.
   4. Staining: Match approved sample for color.
   5. Sheen: Satin, 31-45 gloss units measured on 60-degree gloss meter per ASTM D523.

PART 3 EXECUTION

3.1 PREPARATION

A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.

3.2 INSTALLATION

A. Architectural Woodwork Standards Grade: Install cabinets to comply with quality standard grade of item to be installed.

B. Assemble cabinets and complete fabrication at Project site to extent that it was not completed in the shop.

C. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with cabinet surface.
   1. For shop-finished items, use filler matching finish of items being installed.

D. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm) using concealed shims.
   1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
   2. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
   3. Maintain veneer sequence matching of cabinets with transparent finish.

E. Shop Finishes: Touch up finishing after installation of architectural cabinets. Fill nail holes with matching filler.
   1. Apply specified finish coats, including stains and paste fillers if any, to exposed surfaces where only sealer/prime coats are shop applied.

3.3 ADJUSTING AND CLEANING

A. Repair damaged and defective cabinets, where possible, to eliminate functional and visual defects. Where not possible to repair, replace architectural cabinets. Adjust joinery for uniform appearance.

B. Clean, lubricate, and adjust hardware.

C. Clean cabinets on exposed and semiexposed surfaces. Touch up finishes to restore damaged or soiled areas.

END OF SECTION 064100

SECTION 064113 - WOOD-VENEER-FACED CASEWORK

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Architectural woodwork composed of solid hardwoods and clear hardwood veneer plywoods. NOTE: Substrates shall be either exterior plywood composed of Baltic Birch plys and phenolic exterior glue, or, Purebond formaldahyde-free hardwood plywood which is under consideration by the Owner as an approved substrate, and which may be used as the basis of bidding along with the exterior plywood noted above.
   a. Hardware and accessories.
   b. Custom millwork workstations to include the following (Also see drawings):
      1) Bulletin Surface: Lino-Cork by Forbo or approved equal.
         a) Alternative: Fabric wrapped homasote panels.
      2) Desktop surface: Paperstone.
      3) Millwork as per this spec.
      4) Solid White Oak.
      5) Table Legs: 2” diameter steel leg, powder coated, color TBD, Component Hardware “Stainless Steel Leg Assembly” or similar.
      6) Owner provided pedestal file cabinets.
   c. Wood shelving.
   d. Wood base (Level A).
   e. Wood reveal at top of wall (Level A).
   f. Wood framing and rough lumber as required for work of this Section.
   g. Wood grounds, blocking, nailers, furring as required for work of this Section.
   h. All rough hardware and fastenings for work of this Section.
   i. Drilling concrete and masonry, drilling and/or tapping metal work, as required, for the installation of work of this Section.
   j. Back painting as specified herein.
   k. Shop finish of work of this Section, except items indicated herein to be shop primed only.

B. Related Requirements:
1. Section 061000 "Rough Carpentry" for wood blocking for anchoring casework.
2. Section 092216 "Non-Structural Metal Framing" for reinforcements in metal-framed partitions for anchoring casework.
3. Section 096513 "Resilient Base and Accessories" for resilient base applied to wood-veneer-faced casework.

1.2 DEFINITIONS

A. Definitions in the AWI/AWMAC/WI's "Architectural Woodwork Standards" apply to the Work of this Section.

1.3 QUALIFICATIONS

A. The work of this Section shall be provided by a firm having a minimum of five (5) years' experience on projects of similar size and quality to that specified and shown.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that casework can be supported and installed as indicated.

B. Verify all dimensions in the field prior to fabrication of all Architectural Woodwork to assure proper fit.

1.6 ACTION SUBMITTALS

A. Product Data:
   1. Wood-veneer-faced casework.
   2. Hardware and accessories.

B. Shop Drawings: For wood-veneer-faced casework.
   1. Include plans, elevations, sections, and attachments to other work including blocking and reinforcements required for installation. Room plans and elevations shall be 3/4"=1’-0” and typical construction details at 3”=1’-0”.
   2. Indicate types and sizes of casework.
   3. Indicate manufacturer's catalog numbers for casework.
   4. Show fabrication details, including fastenings, anchors, and types and locations of hardware.
   5. Indicate locations of and clearances from adjacent walls, doors, windows, other building components, and equipment.
   6. Apply AWI's Quality Certification Program label to Shop Drawings.

C. Samples: For casework and hardware finishes.

D. Samples for Verification: For the following:
   1. Casework Finishes: 8-by-10-inch (200-by-250-mm) Samples for each type and color of finish.
   2. Base Cabinet: One full-size, 16-inch- (406-mm-) wide, finished base cabinet complete with hardware, doors, and drawers but without countertop.
   3. Wall Cabinet: One full-size, 12-inch- (304-mm-) wide, finished wall cabinet complete with hardware, doors, and adjustable shelves.
   4. Substrates that comply with these specifications, 12”x12”, definitively labeled by the manufacturer.

5. Cabinet hardware.
6. Counter materials, solid surface, perforated panels, tackboard material, glass, etc., all 12” x12”.

E. Manufacturer’s literature and certifications: For all non-solid wood products, submit complete literature regarding product composition and any adhesives, full MSDS Sheets and manufacturer’s certification that product complies with these specifications.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For casework manufacturer and Installer.

B. Sample Warranty: For special warranty.

C. Field quality-control reports.

1.8 CLOSEOUT SUBMITTALS

A. Quality Standard Compliance Certificates: AWI's Quality Certification Program certificates.

1.9 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish complete touchup kit for each casework finish provided. Include fillers, stains, finishes, and other materials necessary to perform permanent repairs to damaged casework finish.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.

1.11 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install casework until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during remainder of construction period. Maintain temperature and relative humidity during remainder of construction period in range recommended for Project location by the AWI/AWMAC/WI's "Architectural Woodwork Standards."

B. Established Dimensions: Where casework is indicated to fit to other construction, establish dimensions for areas where casework is to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

C. Field Measurements: Where casework is indicated to fit to existing construction, verify dimensions of existing construction by field measurements before fabrication and indicate measurements on Shop Drawings. Provide fillers and scribes to allow for trimming and fitting.

D. Locate concealed framing, blocking, and reinforcements that support casework by field measurements before enclosing them, and indicate measurements on Shop Drawings.

1.12 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of casework that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Delamination of components or other failures of glue bond.
      b. Warping of components.
      c. Failure of operating hardware.
      d. Deterioration of finishes.
   2. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CASEWORK

A. Quality Standard: Unless otherwise indicated, comply with the AWI/AWMAC/WI's "Architectural Woodwork Standards" for grades of casework indicated for construction, finishes, installation, and other requirements.
   1. Grade: Premium.
   2. Provide labels and certificates from AWI certification program indicating that casework complies with requirements of grades specified.

B. Certified Wood: Wood products shall contain not less than 60 percent certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

C. In the event of a dispute as to the quality grade (or grades), the Contractor shall call upon the Architectural Woodwork Institute for an inspection under AWI's Quality Certification Program which shall include a QCP Inspection and Report. The Contractor agrees to abide by the decision of this Report. The cost of said inspection and report shall be borne by the Contractor.

2.2 WOOD-VENEER-FACED CASEWORK (WD-)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Insert manufacturer's name.

B. Source Limitations: Obtain from single source from single manufacturer.

C. Design: Frameless cabinet construction with the following door and drawer-front style:
   1. Flush overlay.

D. Wood Species: As indicated in drawings.
   1. Wood Stain Colors and Finishes: Match Architect's sample.

E. Face Veneer Cut: Plain sliced.

F. Veneer Matching:
   1. None required; select and arrange veneers for compatible grain and color.

G. Grain Direction: As indicated in drawings.

H. Exposed Materials:
   1. Edgebanding: Wood veneer of same species as face veneer.

I. Concealed Materials:
   1. Plywood: Hardwood plywood. Provide backs of same species as faces.

2.3 HARDWARE AND ACCESSORIES

A. Hardware: Miseno MCPBP3400 Madison 4" Center to Center Cabinet Pull.
   1. Finish: Brushed Satin Nickel.
   2. Location: At all cabinet doors and drawer fronts that receive Wood Veneer Finish.

B. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, Type B01602, self-closing. Provide two hinges for doors less than 48 inches (1220 mm) high, and provide three hinges for doors more than 48 inches (1220 mm) high.
   1. Degrees of Opening: 135 degrees.

C. Drawer Slides: ANSI/BHMA A156.9.
   1. Grade 1 and Grade 2: Side mounted.
      a. Heavy Duty (Grade 1HD-100): Undermount.
         1) Type: Full extension.
         2) Material: Zinc-plated ball bearing slides.
         3) Motion Feature: Soft close dampener.
   2. General-purpose drawers; provide 100 lb (45 kg) load capacity.
   3. Grade 1HD-100 and Grade 1HD-200: Side mounted; full-extension type; zinc-plated-steel ball-bearing slides.
   4. For drawers not more than 3 inches high and not more than 24 inches wide, provide Grade 2.
   5. For drawers more than 6 inches high or more than 24 inches wide, provide Grade 1HD-100.

D. Grommets for Cable Passage: 2-inch OD, molded-plastic grommets and matching plastic caps with slot for wire passage.
   1. Color: Black.

E. Waste Bin Pull-Out: Hafele MX Pull-Out Bottom Mount - Double Bins, Black.

F. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2.4 FABRICATION

A. Wood-Veneer-Faced Cabinet Construction: As required by referenced quality standard, but not less than the following:
   1. Bottoms of Cabinets and Tops of Wall Cabinets: 3/4-inch- (19-mm-) thick, veneer-core hardwood plywood.
   2. Ends of Cabinets: 3/4-inch- (19-mm-) thick, hardwood plywood.
   3. Shelves: 3/4-inch- (19-mm-) thick, veneer-core hardwood plywood or 1-inch- (25-mm-) thick.
   4. Base Cabinet Top Frames: 3/4-by-2-inch (19-by-51-mm) solid wood with mortise and tenon or doweled connections, glued and pinned or screwed.
   5. Base Cabinet Stretchers: 3/4-by-4-1/2-inch (19-by-114-mm) plywood, particleboard, or MDF strips or solid-wood boards at front and back of cabinet, glued and pinned or screwed.
   6. Base Cabinet Subtops: 3/4-inch- (19-mm-) thick panel product, glued and pinned or screwed.
   7. Backs of Cabinets: 3/4-inch- (19-mm-) thick, particleboard-core hardwood plywood where exposed, dadoed into sides, bottoms, and tops where not exposed.
   8. Drawer Fronts: 3/4-inch- (19-mm-) thick, particleboard-core hardwood plywood or solid hardwood.
   9. Drawer Sides and Backs: 1/2-inch- (13-mm-) thick, solid-wood or veneer-core hardwood plywood, with glued dovetail or multiple-dowel joints.
   10. Drawer Bottoms: 1/4-inch- (6.4-mm-) thick, veneer-core hardwood plywood, glued and dadoed into front, back, and sides of drawers. Use 1/2-inch- (13-mm-) thick material for drawers more than 24 inches (600 mm) wide.
   11. Drawer Bodies: Steel drawer pans formed from 0.036-inch- (0.91-mm-) thick metal, metallic phosphate treated, and finished with manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat and 2 mils (0.05 mm) for system.
   12. Cabinet Doors:
      a. 48 Inches (1220 mm) or More in Height: 1-1/8 inches (29 mm) thick, with particleboard cores and hardwood face veneers and crossbands.

B. Filler Strips: Provide as needed to close spaces between casework and walls, ceilings, and equipment. Fabricate from same material and with same finish as casework.

2.5 FINISH

A. Preparation: Sand lumber and plywood before assembling. Sand edges of doors and drawer fronts and molded shapes with profile-edge sander. Sand casework after assembling for uniform smoothness at least equivalent to that produced by 220-grit sanding and without machine marks, cross sanding, or other surface blemishes.

B. Staining: Remove fibers and dust and apply wash-coat sealer and stain to exposed and semiexposed surfaces as required to provide uniform color and to match approved Samples.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of framing and reinforcements, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Grade: Install casework to comply with same quality standard grade as item to be installed.

B. Install casework level, plumb, and true in line; shim as required using concealed shims. Where casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.

C. Base Cabinets: Set cabinets straight, level, and plumb. Adjust subtops within 1/16 inch (1.5 mm) of a single plane. Align similar adjoining doors and drawers to a tolerance of 1/16 inch (1.5 mm). Bolt adjacent cabinets together with joints flush, tight, and uniform.

D. Wall Cabinets: Hang cabinets straight, level, and plumb. Adjust fronts and bottoms within 1/16 inch (1.5 mm) of a single plane. Fasten cabinets to hanging strips, masonry, framing, wood blocking, or reinforcements in walls and partitions. Align similar adjoining doors to a tolerance of 1/16 inch (1.5 mm).

E. Fasten casework to adjacent units and to masonry, framing, wood blocking, or reinforcements in walls and partitions to comply with the AWI/AWMAC/WI's "Architectural Woodwork Standards."

F. Install hardware uniformly and precisely. Set hinges snug and flat in mortises unless otherwise indicated. Adjust and align hardware so moving parts operate freely and contact points meet accurately. Allow for final adjustment after installation.

G. Adjust operating hardware so doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

3.3 CLEANING

A. Repair or remove and replace defective work as directed on completion of installation.

B. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.

END OF SECTION 064113

SECTION 064116 - PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Plastic-laminate-clad architectural cabinets.
   2. Wood furring, blocking, shims, and hanging strips for installing plastic-laminate-clad architectural cabinets that are not concealed within other construction.

B. Related Requirements:
   1. Section 061000 "Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing cabinets that are concealed within other construction before cabinet installation.

1.3 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to support loads imposed by installed and fully loaded cabinets.

B. Hardware Coordination: Distribute copies of approved hardware schedule specified in Section 087100 "Door Hardware" to manufacturer of architectural cabinets; coordinate Shop Drawings and fabrication with hardware requirements.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at project job site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.

B. Shop Drawings:
   1. Include plans, elevations, sections, and attachment details.

2. Show large-scale details.
3. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
4. Show locations and sizes of cutouts and holes for items installed in plastic-laminate architectural cabinets.
5. Apply AWI Quality Certification Program label to Shop Drawings.

C. Samples for Verification: For the following:
1. Plastic Laminates: 8 by 10 inches, for each type, color, pattern, and surface finish required.
a. Provide one sample applied to core material with specified edge material applied to one edge.
2. Thermoset Decorative Panels: 8 by 10 inches, for each color, pattern, and surface finish.
a. Provide edge banding on one edge.
3. Corner Pieces:
a. Cabinet-front frame joints between stiles and rails and at exposed end pieces, 18 inches high by 18 inches wide by 6 inches deep.
b. Miter joints for standing trim.
4. Exposed Cabinet Hardware and Accessories: One full-size unit for each type and finish.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

1.7 CLOSEOUT SUBMITTALS

A. Quality Standard Compliance Certificates: certificates.

1.8 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
1. Manufacturer's Certification: Licensed participant in.

B. Installer Qualifications: Manufacturer of products Licensed participant in AWI's Quality Certification Program.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver cabinets until painting and similar finish operations that might damage architectural cabinets have been completed in installation areas. Store cabinets in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.

B. Field Measurements: Where cabinets are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
   1. Locate concealed framing, blocking, and reinforcements that support cabinets by field measurements before being enclosed/concealed by construction, and indicate measurements on Shop Drawings.

PART 2 PRODUCTS

2.1 PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS (PL-)

A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of cabinets indicated for construction, finishes, installation, and other requirements.
   1. Provide labels and certificates from AWI certification program indicating that woodwork and installation complies with requirements of grades specified.
      a. This project has been registered with AWI as AWI Quality Certification Program Number.
   2. The Contract Documents contain requirements that are more stringent than the referenced quality standard. Comply with requirements of Contract Documents in addition to those of the referenced quality standard.

B. Architectural Woodwork Standards Grade: Premium.

C. Type of Construction: Frameless.

D. Door and Drawer-Front Style: Flush overlay.
   1. Reveal Dimension: As indicated.

E. High-Pressure Decorative Laminate: (PL-): Provide basis-of-design product or equivalent product as indicated on Drawings.

F. Exposed Surfaces:
   1. Plastic-Laminate Grade: VGS.
   2. Edges: Grade VGS PVC edge banding, 3.0 mm thick, matching laminate in color, pattern, and finish.
   3. Pattern Direction: Vertical.

G. Semiexposed Surfaces:
   1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, NEMA LD 3, Grade VGS.

a. Edges of Plastic-Laminate Shelves: PVC edge banding, 0.12 inch thick, matching laminate in color, pattern, and finish.
b. For semiexposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, NEMA LD 3, Grade VGS.

2. Drawer Sides and Backs: Thermoset decorative panels with PVC or polyester edge banding.
3. Drawer Bottoms: Thermoset decorative panels.

2.2 CABINET HARDWARE AND ACCESSORIES

A. Cabinet Hardware: Provide cabinet hardware and accessory materials associated with architectural cabinets.
1. Pulls: Top Knobs Riverside 6-5/16 Inch Cabinet Pull.
2. Catches: Magnetic catches, ANSI/BHMA A156.9, B03141.
3. Frameless Concealed Hinges: BHMA A156.9, B01602, degrees of opening, self-closing.
4. Silencers: ANSI/BHMA 156.16, L03021.
5. Adjustable Shelf Standards and Supports: 32mm line boring with anti-tip polycarbonate shelf clips.
6. Door Locks: ANSI/BHMA A156.11, Cam Lock.
a. Coordinate locations with Architect.
7. Drawer Slides: BHMA A156.9.
a. Grade 1 and Grade 2: Side mounted.
1) Type: Full extension.
2) Material: Zinc-plated steel with polymer rollers.
b. Grade 1HD-100 and Grade 1HD-200: Side mounted; full-extension type; zinc-plated-steel ball-bearing slides.
c. For drawers not more than 3 inches high and not more than 24 inches wide, provide Grade 2.
d. For drawers more than 3 inches high, but not more than 6 inches high and not more than 24 inches wide, provide Grade 1.
e. For drawers more than 6 inches high or more than 24 inches wide, provide Grade 1HD-100.
f. For computer keyboard shelves, provide Grade 1.
g. For trash bins not more than 20 inches high and 16 inches wide, provide Grade 1HD-200.
8. Grommets for Cable Passage: 2-inch OD, molded-plastic grommets and matching plastic caps with slot for wire passage.
a. Color: Black.
9. Waste Bin Pull-Out: Hafele MX Pull-Out Bottom Mount - Double Bins, Black.

B. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2.3 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln-dried to less than 15 percent moisture content.

B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

C. Adhesive for Bonding Plastic Laminate: Manufacturers Recommended.
   1. Adhesive for Bonding Edges: Manufacturers Recommended.

2.4 FABRICATION

A. Fabricate architectural cabinets to dimensions, profiles, and details indicated.

B. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
   1. Notify Architect seven days in advance of the dates and times architectural cabinet fabrication will be complete.
   2. Trial fit assemblies at manufacturer's shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements before disassembling for shipment.

C. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

PART 3 EXECUTION

3.1 PREPARATION

A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.

3.2 INSTALLATION

A. Architectural Woodwork Standards Grade: Install cabinets to comply with quality standard grade of item to be installed.

B. Assemble cabinets and complete fabrication at Project site to extent that it was not completed in the shop.

C. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with wafer-head cabinet installation screws.

D. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches using concealed shims.
   1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
   2. Install cabinets without distortion so doors and drawer’s fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
   3. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches o.c. with No. 10 wafer-head screws sized for not less than 1-1/2-inch penetration into wood framing, blocking, or hanging strips No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish.

3.3 FIELD QUALITY CONTROL

A. Inspections: Provide inspection of installed Work through AWI's Quality Certification Program certifying that woodwork, including installation, complies with requirements of the Architectural Woodwork Standards for the specified grade.
   1. Inspection entity shall prepare and submit report of inspection.

3.4 ADJUSTING AND CLEANING

A. Repair damaged and defective cabinets, where possible, to eliminate functional and visual defects. Where not possible to repair, replace architectural cabinets. Adjust joinery for uniform appearance.

B. Clean, lubricate, and adjust hardware.

C. Clean cabinets on exposed and semiexposed surfaces.

END OF SECTION 064116

SECTION 066100 - REMOVABLE TARP

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Removable, reusable heavy duty tarp.

B. Hooks to connect to eyelets.

1.2 RELATED REQUIREMENTS

A. Section 051200: Structural Steel Framing.

B. Section 055000: Metal Fabrications.

1.3 SUBMITTALS

A. Product Data: Material properties, grommet sizes, colors.

B. Shop Drawings: Indicate hooks for connecting to eyelets steel columns.

C. Samples: One sample of tarp, 12 by 12 inches in size, indicating grommet size and attachment.

D. Manufacturer's Instructions: Indicate attachment and removal of tarp..

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least three years of documented experience.

1.5 WARRANTY

A. See Section 017700 - Closeout Procedures for additional warranty requirements.

B. Manufacturer Warranty: Provide 3-year manufacturer warranty for failure of tarp, grommets, or attachment hardware. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Subject to compliance with requirements, provide Heavy Duty Custom Tarps manufactured by Covers&All; products indicated on drawings or comparable product by one of the following:
   1. Tarps&All.
   2. TarpsNow.
   3. Alco Covers.

B. Source Limitations: Furnish products produced by single manufacturer and obtained from single supplier.

2.2 PERFORMANCE REQUIREMENTS

A. Meet wind and other loading requirements as shown on Drawings.

B. Coordinate installation of tarp fasteners with construction of canopy columns.

2.3 MATERIALS

A. Tarp: 1000 Denier, 15 Mil Thick, PVC Coated Polyester.
   1. Waterproof.
   2. High UV Resistance.
   3. Weight: 12 oz.
   4. Color: As selected by Architect.
   5. Dimensions: as shown on Drawings.

B. Hook:
   1. Material: As recommended by manufacturer,
   2. Color: As selected by Architect.
   3. Size: Manufacturer's standard to attach to metal eyelet on column.
   4. Number: 4 per tarp (1 in each corner).

PART 3 EXECUTION

3.1 DEMONSTRATION

A. Install tarp to existing column to demonstrate and train Owner on how it is to be mounted.

B. Install tarp to confirm configuration.

C. Remove tarp after demonstration and store at location as directed by Owner.

3.2 PROTECTION

A. Protect installed tarp and fasteners from subsequent construction operations.

END OF SECTION 066100

SECTION 068316 - FIBERGLASS REINFORCED PANELING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Fiberglass reinforced plastic panels.

B. Trim.

1.2 RELATED REQUIREMENTS

A. Section 092116 - Gypsum Board Assemblies.

1.3 REFERENCE STANDARDS

A. 9 CFR 416.2 - Regulatory Requirements Under the Federal Meat Inspection Act and the Poultry Products Inspection Act, Part 416-Sanitation; current edition.

B. ASTM D256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics; 2023, with Editorial Revision.

C. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber; 2021.

D. ASTM D5319 - Standard Specification for Glass-Fiber Reinforced Polyester Wall and Ceiling Panels; 2017.

E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.

F. FDA Food Code - Chapter 6 - Physical Facilities; Current Edition.

G. FM 4880 - Evaluating the Fire Performance of Insulated Building Panel Assemblies and Interior Finish Materials; 2017.

H. ISO 846 - Plastics - Evaluation of the Action of Microorganisms; 2019.

I. ISO 2812-1 - Paints and Varnishes -- Determination of Resistance to Liquids -- Part 1: Immersion in Liquids Other than Water; 2017.

1.4 SUBMITTALS

A. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.

B. Samples: Submit two samples 6 by 6 inch in size illustrating material and surface design of panels.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store panels flat, indoors, on a clean, dry surface. Remove packaging and allow panels to acclimate to room temperature for 48 hours prior to installation.

1.6 WARRANTY

A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Deterioration of plastic and other materials beyond normal use.
   2. Warranty Period: One year from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Fiberglass Reinforced Plastic Panels:
   1. Crane Composites, Inc: www.cranecomposites.com/#sle.
   2. Marlite, Inc: www.marlite.com/#sle.
   3. Nudo Products, Inc: www.nudo.com/#sle.
   4. Panolam Industries International, Inc: www.panolam.com/#sle.

2.2 PANEL SYSTEMS

A. Wall Panels:
   1. Panel Size: 4 by 8 feet.
   2. Panel Thickness: 0.09 inch.
   3. Surface Design: Smooth.
   4. Color: As selected by Architect.
   5. Attachment Method: Adhesive only, with trim and sealant in joints.

2.3 MATERIALS

A. Panels: Glass fiber reinforced plastic (FRP), complying with ASTM D5319 and meeting USDA requirements.
   1. Surface Burning Characteristics: Maximum flame spread index of 25 and smoke

developed index of 450; when system tested in accordance with ASTM E84.
2. Class 1 fire rated when tested in accordance with FM 4880.
3. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
4. Impact Strength: Greater than 6 ft lb force per inch, when tested in accordance with ASTM D256.
5. Surface Characteristics and Cleanability: Provide products that are smooth, durable, and easily cleanable, in compliance with FDA Food Code, Chapter 6 - Physical Facilities.
6. Biological Resistance: Rating of 0, when tested in accordance with ISO 846.

B. Trim: Aluminum; color coordinating with panel.

C. Adhesive: Type recommended by panel manufacturer.

D. Sealant: Type recommended by panel manufacturer; white.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing conditions and substrate flatness before starting work.

B. Verify that substrate conditions are ready to receive the work of this section.

3.2 INSTALLATION - WALLS

A. Install panels in accordance with manufacturer's instructions.

B. Cut and drill panels with carbide tipped saw blades, drill bits, or snips.

C. Apply adhesive to the back side of the panel using trowel as recommended by adhesive manufacturer.

D. Apply panels to wall with seams plumb and pattern aligned with adjoining panels.

E. Install panels with manufacturer's recommended gap for panel field and corner joints.

F. Place trim on panel before fastening edges, as required.

G. Fill channels in trim with sealant before attaching to panel.

H. Seal gaps at floor, ceiling, and between panels with applicable sealant to prevent moisture intrusion.

I. Remove excess sealant after paneling is installed and prior to curing.

END OF SECTION 068316

SECTION 071113 - BITUMINOUS DAMP PROOFING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Cold-applied, emulsified-asphalt dampproofing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 FIELD CONDITIONS

A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit dampproofing to be performed according to manufacturers' written instructions.

B. Ventilation: Provide adequate ventilation during application of dampproofing in enclosed spaces. Maintain ventilation until dampproofing has cured.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain primary dampproofing materials and primers from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. VOC Content: Products shall comply with VOC content limits of authorities having jurisdiction unless otherwise indicated.

2.3 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. BASF Corporation.
   2. Henry Company.
   3. Karnak Corporation.
   4. W.R. Meadows, Inc.

B. Trowel Coats: ASTM D 1227, Type II, Class 1.

C. Fibered Brush and Spray Coats: ASTM D 1227, Type II, Class 1.

D. VOC Content: 0.25 lb/gal. or less.

2.4 AUXILIARY MATERIALS

A. Furnish auxiliary materials recommended in writing by dampproofing manufacturer for intended use and compatible with bituminous dampproofing.

B. Emulsified-Asphalt Primer: ASTM D 1227, Type III, Class 1, except diluted with water as recommended in writing by manufacturer.

C. Asphalt-Coated Glass Fabric: ASTM D 1668/D 1668M, Type I.

D. Patching Compound: Asbestos-free fibered mastic of type recommended in writing by dampproofing manufacturer.

E. Protection Course at Concrete Foundations: Extruded-polystyrene board insulation, unfaced, ASTM C 578, Type X, 1/2 inch thick.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for surface smoothness, maximum surface moisture content, and other conditions affecting performance of the Work.

B. Proceed with application only after substrate construction and penetrating work have been completed and unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for dampproofing application.

B. Mask or otherwise protect adjoining exposed surfaces from being stained, spotted, or coated with dampproofing. Prevent dampproofing materials from entering and clogging weep holes and drains.

C. Clean substrates of projections and substances detrimental to dampproofing work; fill voids, seal joints, and remove bond breakers if any.

D. Apply patching compound to patch and fill tie holes, honeycombs, reveals, and other imperfections; cover with asphalt-coated glass fabric.

3.3 APPLICATION, GENERAL

A. Comply with manufacturer's written instructions for dampproofing application, cure time between coats, and drying time before backfilling unless otherwise indicated.
   1. Apply dampproofing to provide continuous plane of protection.
   2. Apply additional coats if recommended in writing by manufacturer or to achieve a smooth surface and uninterrupted coverage.
   3. Comply with manufacturer's instructions for drying time but allow no less than 48-hours prior to backfilling.

B. Where dampproofing footings and foundation walls, apply from finish floor elevation to top of footing; extend over top of footing and down a minimum of 6 inches over outside face of footing.
   1. Extend dampproofing 12 inches onto intersecting walls and footings, but do not extend onto surfaces exposed to view when Project is completed.
   2. Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints, cracks, and where indicated as "reinforced," by embedding an 8-inch- wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing. Dampproofing coat for embedding fabric is in addition to other coats required.

3.4 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. Concrete Foundations and Masonry Foundation Walls: Apply two brush or spray coats at not less than 1.5 gal./100 sq. ft. for first coat and 1 gal./100 sq. ft. for second coat, one fibered brush or spray coat at not less than 3 gal./100 sq. ft. or one trowel coat at not less than 4 gal./100 sq. ft.

3.5 PROTECTION COURSE INSTALLATION

A. Concrete Foundations: Install protection course over completed-and-cured dampproofing. Comply with dampproofing-material and protection-course manufacturers' written instructions for attaching protection course.

3.6 PROTECTION

A. Protect installed insulation drainage panels from damage due to UV light, harmful weather

exposures, physical abuse, and other causes. Provide temporary coverings where panels are subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

B. Correct dampproofing that does not comply with requirements; repair substrates, and reapply dampproofing.

C. CLEANING.

D. Clean and remove dampproofing materials from any adjacent surfaces not indicated to receive dampproofing.

END OF SECTION 071113

SECTION 072100 - THERMAL INSULATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Extruded polystyrene foam-plastic board.
   2. Glass-fiber blanket.
   3. Mineral-wool board.

B. Related Requirements:
   1. Section 042000 "Unit Masonry" for insulation installed in masonry cells.
   2. Section 092900 "Gypsum Board" for sound attenuation blanket used as acoustic insulation.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each product, for tests performed by a qualified testing agency.

B. Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect foam-plastic board insulation as follows:
   1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
   2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
   3. Quickly complete installation and concealment of foam-plastic board insulation in each

area of construction.

PART 2 PRODUCTS

2.1 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD

A. Extruded polystyrene boards in this article are also called "XPS boards." Roman numeral designators in ASTM C 578 are assigned in a fixed random sequence, and their numeric order does not reflect increasing strength or other characteristics.

B. Extruded Polystyrene Board, Type VI: ASTM C 578, Type VI, 40-psi minimum compressive strength; maximum flame-spread and smoke-developed indexes of 25 and 450, respectively, per ASTM E 84.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. DiversiFoam Products.
      b. Dow Chemical Company (The).
      c. Owens Corning.
      d. Soprema, Inc.

2.2 GLASS-FIBER BLANKET

A. Glass-Fiber Blanket, Reinforced-Foil Faced: ASTM C 665, Type III (reflective faced), Class A (faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier), faced with foil scrim, foil-scrim kraft, or foil-scrim polyethylene.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. CertainTeed Corporation.
      b. Johns Manville; a Berkshire Hathaway company.
      c. Knauf Insulation.
      d. Owens Corning.

2.3 MINERAL-WOOL BOARD

A. Mineral-Wool Board, Type II, Unfaced: ASTM C 612, Type II; with maximum flame-spread and smoke-developed indexes of 15 and zero, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics. Nominal density of 6 lb/cu. ft.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide ROCKWOOL (ROXUL Inc.); CAVITYROCK or a comparable product by one of the following:
      a. Johns Manville; a Berkshire Hathaway company.
      b. Thermafiber, Inc.; an Owens Corning company.

2.4 INSULATION FASTENERS

A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. AGM Industries, Inc.
      b. Gemco.
   2. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   3. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation.

B. Adhesively Attached, Angle-Shaped, Spindle-Type Anchors: Angle welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Gemco.
   2. Angle: Formed from 0.030-inch- thick, perforated, galvanized carbon-steel sheet with each leg 2 inches square.
   3. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation.

C. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches square or in diameter.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. AGM Industries, Inc.
      b. Gemco.
   2. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:
      a. Crawl spaces.
      b. Ceiling plenums.
      c. Attic spaces.

D. Insulation Standoff: Spacer fabricated from galvanized mild-steel sheet for fitting over spindle of insulation anchor to maintain air space of 1 inch between face of insulation and substrate to which anchor is attached.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Gemco.

E. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates without damaging insulation, fasteners, or substrates.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. AGM Industries, Inc.
      b. Gemco.

2.5 ACCESSORIES

A. Insulation for Miscellaneous Voids:
   1. Glass-Fiber Insulation: ASTM C 764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E 84.

B. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.3 INSTALLATION OF SLAB INSULATION

A. On vertical slab edge and foundation surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.
   1. If not otherwise indicated, extend insulation a minimum of 2'-0" below exterior grade

line.

B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.
   1. If not otherwise indicated, extend insulation a minimum of 2'-0" in from exterior walls.

3.4 INSTALLATION OF FOUNDATION WALL INSULATION

A. Butt panels together for tight fit.

B. Anchor Installation: Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:
   1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application.
   2. Apply insulation standoffs to each spindle to create cavity width indicated on Drawings between concrete substrate and insulation.
   3. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation.
   4. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

C. Adhesive Installation: Install with adhesive or press into tacky waterproofing or dampproofing according to manufacturer's written instructions.

3.5 INSTALLATION OF CAVITY-WALL INSULATION

A. Foam-Plastic Board Insulation: Install pads of adhesive spaced approximately 24 inches o.c. both ways on inside face and as recommended by manufacturer. Fit courses of insulation between wall ties and other obstructions, with edges butted tightly in both directions. Press units firmly against inside substrates.
   1. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Section 042000 "Unit Masonry."

B. Cellular-Glass Board Insulation: Install with closely fitting joints using serrated trowel attachment method according to manufacturer's written instructions.

3.6 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
   1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
   2. Place insulation in cavities formed by framing members to produce a friction fit between

edges of insulation and adjoining framing members.

3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
4. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
5. Vapor-Retarder-Faced Blankets: Tape joints and ruptures in vapor-retarder facings, and seal each continuous area of insulation to ensure airtight installation.
    a. Exterior Walls: Set units with facing placed toward interior of construction.
    b. Interior Walls: Set units with facing placed toward areas of high humidity.

B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft.
2. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

3.7 INSTALLATION OF CURTAIN-WALL INSULATION

A. Install board insulation in curtain-wall construction according to curtain-wall manufacturer's written instructions.
1. Hold insulation in place by securing metal clips and straps or integral pockets within window frames, spaced at intervals recommended in writing by insulation manufacturer to hold insulation securely in place without touching spandrel glass. Maintain cavity width of dimension indicated on Drawings between insulation and glass.
2. Install insulation to fit snugly without bowing.

3.8 INSTALLATION OF REFLECTIVE INSULATION

A. Install sheet reflective insulation according to ASTM C 727.

B. Install sheet radiant barriers according to ASTM C 1744.

C. Install interior radiation control coating system according to ASTM C 1321.

3.9 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 072100

SECTION 072119 - FOAMED-IN-PLACE INSULATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Open-cell spray polyurethane foam.

B. Related Requirements:
   1. Section 072100 "Thermal Insulation" for foam-plastic board insulation.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

C. Evaluation Reports: For spray-applied polyurethane foam-plastic insulation, from ICC-ES.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

PART 2 PRODUCTS

2.1 OPEN-CELL SPRAY POLYURETHANE FOAM

A. Open-Cell Spray Polyurethane Foam: Spray-applied polyurethane foam using water as a blowing agent. Minimum density of 0.4 lb/cu. ft. and minimum aged R-value at 1-inch thickness of 3.4 deg F x h x sq. ft./Btu at 75 deg F.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers

offering products that may be incorporated into the Work include, but are not limited to, the following:
a. BASF Corporation.
b. CertainTeed Corporation.
c. Covestro LLC; Polyurethanes (formerly Bayer MaterialScience).
d. Demilec (USA) LLC.
e. Gaco Western LLC.
f. Henry Company.
g. Icynene Inc.
h. Johns Manville; a Berkshire Hathaway company.
i. NCFI Polyurethanes; a division of Barnhardt Manufacturing Company.
j. SWD Urethane Company.

2. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   a. Flame-Spread Index: 25 or less.
   b. Smoke-Developed Index: 450 or less.
3. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.

PART 3 EXECUTION

3.1 PREPARATION

A. Verify that substrates are clean, dry, and free of substances that are harmful to insulation.

3.2 INSTALLATION

A. Comply with insulation manufacturer's written instructions applicable to products and applications.

B. Spray insulation to envelop entire area to be insulated and fill voids.

C. Apply in multiple passes to not exceed maximum thicknesses recommended by manufacturer. Do not spray into rising foam.

D. Framed Construction: Install into cavities formed by framing members as indicated on Drawings.

E. Miscellaneous Voids: Apply according to manufacturer's written instructions.

3.3 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.

END OF SECTION 072119

SECTION 072713 - MODIFIED BITUMINOUS SHEET AIR BARRIERS

PART 1 GENERAL

1.1 SUMMARY

A. Work Results:

B. Principal Products:

C. Section Includes: Self-adhering, vapor-retarding, air barrier.
   1. Modified bituminous sheet.

D. Related Requirements:
   1. Section 061600 "Sheathing" for wall sheathings and wall sheathing joint-and-penetration treatments.
   2. Section 072715 "Nonbituminous Self-Adhering Sheet Air Barriers" for self-adhering sheet air barriers composed of nonbituminous polymers.

1.2 DEFINITIONS

A. Air-Barrier Accessory: A transitional component of the air barrier that provides continuity.

B. Air-Barrier Assembly: The collection of air-barrier materials and accessories applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

C. Air-Barrier Material: A primary element that provides a continuous barrier to the movement of air.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review air-barrier requirements and installation, special details, mockups, air-leakage and bond testing, air-barrier protection, and work scheduling that covers air barriers.

1.4 ACTION SUBMITTALS

A. Product Data: Self-adhering, vapor-retarding, sheet air barrier. Include manufacturer's written instructions for evaluating, preparing, and treating each substrate; technical data; and tested physical and performance properties of products.
   1. Modified bituminous sheet.
   2. Aluminum-faced modified bituminous sheet.

B. Shop Drawings: For air-barrier assemblies.
   1. Show locations and extent of air barrier materials, accessories, and assemblies specific to Project conditions.
   2. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
   3. Include details of interfaces with other materials that form part of air barrier.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer. Include list of ABAA-certified installers and supervisors employed by Installer, who work on Project.

B. Product Certificates: From air-barrier manufacturer, certifying compatibility of air barriers and accessory materials with Project materials that connect to or that come in contact with air barrier.

C. Product Test Reports: For each air-barrier assembly, for tests performed by a qualified testing agency.

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
   1. Installer to be licensed by ABAA in accordance with ABAA's Quality Assurance Program and to employ ABAA-certified installers and supervisors on Project.

B. Mockups: Build mockups to set quality standards for materials and execution and for preconstruction testing.
   1. Build integrated mockups of exterior wall assembly , 150 sq. ft. (14 sq. m), incorporating backup wall construction, external cladding, window, storefront, door frame and sill, insulation, ties and other penetrations, and flashing to demonstrate surface preparation, crack and joint treatment, application of air barriers, and sealing of gaps, terminations, and penetrations of air-barrier assembly.
      a. Coordinate construction of mockups to permit inspection and testing of air barrier before external insulation and cladding are installed.
      b. Include junction with roofing membrane, building corner condition, and foundation wall intersection.
      c. If Architect determines mockups do not comply with requirements, reconstruct mockups and apply air barrier until mockups are approved.
   2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer’s warranty shall include flashing tie-in materials at transitions between building envelope systems when the building envelope system materials and flashing tie-in materials are manufacturerd by a single source.
   1. Warranty Period: Ten years from date of Final Completion.

B. Installer's Special Warranty: Specified form, signed by Installer, covering Work of this Section, for warranty period of two years.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on field mockups.

B. Mockup Testing: Air-barrier assemblies to comply with performance requirements indicated, as evidenced by reports based on mockup testing by a qualified testing agency.
   1. Air-Leakage-Location Testing: Mockups will be tested for evidence of air leakage in accordance with ASTM E1186, chamber pressurization or depressurization with smoke tracers.
   2. Air-Leakage-Volume Testing: Mockups will be tested for air-leakage rate in accordance with ASTM E783.
   3. Adhesion Testing: Mockups will be tested for required air-barrier adhesion to substrate in accordance with ASTM D4541.
   4. Notify Architect seven days in advance of the dates and times when mockups will be tested.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Remove and replace liquid materials that cannot be applied within their stated shelf life.

B. Protect stored materials from direct sunlight.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended in writing by air-barrier manufacturer.
   1. Protect substrates from environmental conditions that affect air-barrier performance.
   2. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

PART 2 PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain primary air-barrier materials and air-barrier accessories from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Air-Barrier Performance: Air-barrier assembly and seals with adjacent construction to be capable of performing as a continuous air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies to be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, tie-ins to installed waterproofing, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

B. Air-Barrier Assembly Air Leakage: Maximum 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft. (0.2 L/s x sq. m of surface area at 75 Pa), when tested in accordance with ASTM E2357.

2.3 SELF-ADHERING SHEET AIR BARRIER

A. Modified Bituminous Sheet: 40-mil- (1.0-mm-) thick, self-adhering sheet consisting of 36 mils (0.9 mm) of rubberized asphalt laminated to a 4-mil- (0.1-mm-) thick, cross-laminated polyethylene film with release liner on adhesive side.
   1. Physical and Performance Properties:
      a. Air Permeance: Maximum 0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. (0.02 L/s x sq. m of surface area at 75-Pa) pressure difference; ASTM E2178.
      b. Tensile Strength: Minimum 250 psi (1.7 MPa); ASTM D412, Die C.
      c. Ultimate Elongation: Minimum 200 percent; ASTM D412, Die C.
      d. Puncture Resistance: Minimum 40 lbf (180 N); ASTM E154/E154M.
      e. Water Absorption: Maximum 0.15 percent weight gain after 48-hour immersion at 70 deg F (21 deg C); ASTM D570.
      f. Vapor Permeance: Maximum 0.1 perm (5.8 ng/Pa x s x sq. m); ASTM E96/E96M, Desiccant Method.
      g. Adhesion to Substrate: Minimum 94 psi when tested in accordance with ASTM D4541 as modified by ABAA.
      h. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
      i. UV Resistance: Can be exposed to sunlight for 30 days in accordance with manufacturer's written instructions.

2.4 ACCESSORY MATERIALS

A. Requirement: Provide primers, transition strips, termination strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by air-barrier manufacturer to produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal.

B. Primer: Liquid primer recommended for substrate by air-barrier material manufacturer.

C. Stainless Steel Sheet: ASTM A240/A240M, Type 304, 0.0250 inch (0.64 mm) thick, and

Series 300 stainless steel fasteners.

D. Preformed Silicone Extrusion: Manufacturer's standard system consisting of cured low-modulus silicone extrusion, sized to fit opening widths, with a single-component, neutral-curing, Class 100/50 (low-modulus) silicone sealant for bonding extrusions to substrates.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
   1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
   2. Verify that substrates have cured and aged for minimum time recommended in writing by air-barrier manufacturer.
   3. Verify that substrates are visibly dry and free of moisture.
   4. Verify that masonry joints are flush and completely filled with mortar.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

A. Clean, prepare, treat, fill, and seal substrate and joints and cracks in substrate in accordance with manufacturer's written instructions and details. Provide clean, dust-free, and dry substrate for air-barrier application.

B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.

C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching membrane.

E. Remove excess mortar from masonry ties, shelf angles, and other obstructions.

F. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.

G. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.

H. Bridge isolation joints and expansion joints discontinuous wall-to-wall, deck-to-wall, and deck-to-deck joints with air-barrier accessory material that accommodates joint movement in accordance with manufacturer's written instructions and details.

3.3 INSTALLATION OF SELF-ADHERING SHEET AIR BARRIER

A. Install materials in accordance with air-barrier manufacturer's written instructions and details and in accordance with recommendations in ASTM D6135 to form a seal with adjacent construction and ensure continuity of air and water barrier.
   1. When ambient and substrate temperatures range between 25 and 40 deg F (minus 4 and plus 5 deg C), install self-adhering, modified bituminous air-barrier sheet produced for low-temperature application. Do not install low-temperature sheet if ambient or substrate temperature is higher than 60 deg F (16 deg C).
   2. Unless manufacturer recommends in writing against priming, apply primer to substrates at required rate and allow it to dry.

B. Prepare, treat, and seal inside and outside corners and vertical and horizontal surfaces at terminations and penetrations with termination mastic and in accordance with ASTM D6135.

C. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by air-barrier sheet on same day. Reprime areas exposed for more than 24 hours.

D. Apply and firmly adhere air-barrier sheets over area to receive air barrier. Accurately align sheets and maintain uniform 2-1/2-inch- (64-mm-) minimum lap widths and end laps. Overlap and seal seams, and stagger end laps to ensure airtight installation.
   1. Apply sheets in a shingled manner to shed water.
   2. Roll sheets firmly to enhance adhesion to substrate.

E. Apply continuous air-barrier sheets over accessory strips bridging substrate cracks, construction, and contraction joints.

F. Seal top of through-wall flashings to air-barrier sheet with an additional 6-inch- (150-mm-) wide, transition strip.

G. Seal exposed edges of sheet at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.

H. Install air-barrier sheet and accessory materials to form a seal with adjacent construction and to maintain a continuous air barrier.
   1. Coordinate air-barrier installation with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
   2. Install transition strip on roofing membrane or base flashing so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate.

I. Connect and seal exterior wall air-barrier sheet continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.

J. At end of each working day, seal top edge of air-barrier material to substrate with termination mastic.

K. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended

application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

L. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply transition strip so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate. Maintain 3 inches (75 mm) of contact over firm bearing to perimeter frames, with not less than 1 inch (25 mm) of full contact.
1. Transition Strip: Roll firmly to enhance adhesion.
2. Preformed Silicone Extrusion: Set in full bed of silicone sealant applied to walls, frame, and air-barrier material.

M. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, doors, and miscellaneous penetrations of air-barrier material with foam sealant.

N. Repair punctures, voids, and deficient lapped seams in air barrier. Slit and flatten fishmouths and blisters. Patch with air-barrier sheet extending 6 inches (150 mm) beyond repaired areas in all directions.

O. Do not cover air barrier until it has been tested and inspected by testing agency.

P. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.4 FIELD QUALITY CONTROL

A. ABAA Quality Assurance Program: Perform examinations, preparation, installation, testing, and inspections under ABAA's Quality Assurance Program.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Inspections: Air-barrier materials, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:
1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
2. Continuous structural support of air-barrier system has been provided.
3. Masonry and concrete surfaces are smooth, clean, and free of cavities, protrusions, and mortar droppings.
4. Site conditions for application temperature and dryness of substrates have been maintained.
5. Maximum exposure time of materials to UV deterioration has not been exceeded.
6. Surfaces have been primed.
7. Laps in sheet materials have complied with the minimum requirements and have been shingled in the correct direction (or mastic applied on exposed edges), with no fishmouths.
8. Termination mastic has been applied on cut edges.
9. Air barrier has been firmly adhered to substrate.
10. Compatible materials have been used.
11. Transitions at changes in direction and structural support at gaps have been provided.

12. Connections between assemblies (air barrier and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
13. All penetrations have been sealed.

D. Tests: As determined by testing agency from among the following tests:
1. Air-Leakage-Location Testing: Air-barrier assemblies will be tested for evidence of air leakage in accordance with ASTM E1186, chamber pressurization or depressurization with smoke tracers.
2. Air-Leakage-Volume Testing: Air-barrier assemblies will be tested for air-leakage rate in accordance with ASTM E783.
3. Adhesion Testing: Air-barrier assemblies will be tested for required adhesion to substrate in accordance with ASTM D4541 for each 600 sq. ft. (56 sq. m) of installed air barrier or part thereof.

E. Air barriers will be considered defective if they do not pass tests and inspections.
1. Apply additional air-barrier material, in accordance with manufacturer's written instructions, where inspection results indicate insufficient thickness.
2. Remove and replace deficient air-barrier components for retesting as specified above.

F. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

G. Prepare test and inspection reports.

3.5 CLEANING AND PROTECTION

A. Protect air-barrier system from damage during application and remainder of construction period, in accordance with manufacturer's written instructions.
1. Protect air barrier from exposure to UV light and harmful weather exposure as recommended in writing by manufacturer. If exposed to these conditions for longer than recommended, remove and replace air barrier or install additional, full-thickness, air-barrier application after repairing and preparing the overexposed materials in accordance with air-barrier manufacturer's written instructions.
2. Protect air barrier from contact with incompatible materials and sealants not approved by air-barrier manufacturer.

B. Clean spills, stains, and soiling from construction that would be exposed in the completed Work, using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION 072713

SECTION 074113 - METAL ROOF PANELS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Metal roof panel system of preformed steel panels.

B. Accessories and miscellaneous components.

C. Underlayment.

1.2 RELATED REQUIREMENTS

A. Section 051200 - Structural Steel Framing: Roof framing and purlins.

B. Section 061000 - Rough Carpentry: Roof sheathing.

1.3 REFERENCE STANDARDS

A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.

B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.

C. ASTM E1592 - Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference; 2005 (Reapproved 2017).

D. ASTM E1646 - Standard Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference; 1995 (Reapproved 2018).

1.4 PREINSTALLATION MEETINGS

A. Preliminary Roofing Conference: Conduct conference at Project Site at least six weeks prior to anticipated start of roofing.
   1. Meet with Owner, Architect, Owner's insurer if applicable, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of roof accessories and roof-mounted equipment.
   2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   3. Review methods and procedures related to metal panel installation, including

manufacturer's written instructions.

4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
5. Review structural loading limitations of deck during and after roofing.
6. Review flashings, special details, drainage, penetrations, equipment curbs, and condition of other construction that affect metal panels.
7. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
8. Review temporary protection requirements for metal panel systems during and after installation.
9. Review procedures for repair of metal panels damaged after installation.
10. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

B. Preinstallation Conference: Conduct conference at Project site within one week of roofing application.
   1. Verify readiness of the project structure.
   2. Review any changes or corrections to details.
   3. Review anticipated schedule of progress.

C. Final Inspection Conference: Conduct conference at Project site just before roofing work is complete.
   1. With attendees from Preinstallation Conference, walk the complete roof.
   2. Establish final punch list items.
   3. Review summary of project records.
   4. Review recommended maintenance program.
   5. Review roof protection strategy through final completion.
   6. Review requirements of final acceptance, including submission of fully executed guarantees.

1.5 SUBMITTALS

A. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Summary of test results, indicating compliance with specified requirements.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.
   4. Specimen warranty.
   5. MSDS sheets.

B. Shop Drawings: Include layouts of roof panels, details of edge and penetration conditions, spacing and type of connections, flashings, underlayments, and special conditions.
   1. Show work to be field-fabricated or field-assembled.
   2. Include structural analysis signed and sealed by qualified structural engineer, indicating compliance of roofing system to specified loading conditions.

C. Verification Samples: For each roofing system specified, submit samples of minimum size 12 inches square, representing actual roofing metal, thickness, profile, color, and texture.

D. Test Reports: Indicate compliance of metal roofing system to specified requirements.

E. Warranty: Submit specified manufacturer's warranty and ensure that forms have been completed in Owner's name and are registered with manufacturer.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than five years of experience.

B. Installer Qualifications: Company specializing in performing work of the type specified and with at least five years of experience.

C. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Provide strippable plastic protection on prefinished roofing panels for removal after installation.

B. Store roofing panels on project site as recommended by manufacturer to minimize damage to panels prior to installation.

1.8 FIELD CONDITIONS

A. Do not install metal roof panels, eave protection membrane, underlayment, or _____ when surface, ambient air, or wind chill temperatures are below 45 degrees F.

1.9 WARRANTY

A. Special Galvalume Substrate Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including rupturing, or perforating.
      b. Deterioration of metals and other materials beyond normal weathering.

B. Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.

c. Cracking, chipping, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

C. Special Watertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain watertight, including leaks, within specified warranty period.

1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Structural Metal Roof Panel Manufacturers:

1. Basis of Design: Subject to compliance with requirements, provide Berridge Manufacturing Double-Zee Lock Standing Seam Roof or comparable product by one of the following:
2. MBCI; 7.2 Panel: www.mbci.com/#sle.
3. Taylor Metal Products; BR - 36: www.taylormetal.com/#sle.
4. Peterson Snap-Clad Metal Panel: www.pac-clad.com.

2.2 PERFORMANCE REQUIREMENTS

A. Metal Roof Panels: Provide complete roofing assemblies, including roof panels, clips, fasteners, connectors, and miscellaneous accessories, tested for compliance with the following minimum standards:

1. Structural Design Criteria: Provide panel assemblies designed to safely support design loads at support spacing indicated, with deflection not to exceed L/180 of span length(L) when tested in accordance with ASTM E1592.
   a. Dead Loads: Weight of roofing system.
   b. Live Loads: As indicated on drawings.
      1) Design wind pressures are indicated on the drawings.
2. Overall: Complete weathertight system tested and approved in accordance with ASTM E1592.
3. Water Penetration: No water penetration when tested in accordance with procedures and recommended test pressures of ASTM E1646; perform test immediately following air infiltration test.
4. Thermal Movement: Design system to accommodate without deformation anticipated thermal movement over ambient temperature range of 100 degrees F.

2.3 METAL ROOF PANELS

A. Metal Roof Panels: Provide complete engineered system complying with specified requirements and capable of remaining weathertight while withstanding anticipated movement of substrate and thermally induced movement of roofing system.

B. Metal Panels: Factory-formed panels with factory-applied finish.

1. Steel Panels:

a. Steel Thickness: Minimum 24 gauge, 0.024 inch.

2. Profile: Standing seam, with minimum 2.0 inch seam height, 180° standing mechanically seamed sidelap and concealed fasteners.
3. Texture: Smooth.
4. Length: Full length of roof slope, without lapped horizontal joints.
5. Width: Maximum panel coverage of 16 inches.

2.4 ATTACHMENT SYSTEM

A. Concealed System: Provide manufacturer's standard stainless steel concealed anchor clips designed for specific roofing system and engineered to meet performance requirements, including anticipated thermal movement.

2.5 SECONDARY FRAMING

A. Miscellaneous Secondary Framing: Light gauge steel framing incidental to structural supports; fabricated from steel sheet.

B. Framing Material: Galvalume steel sheet.
1. Profile: Manufacturer's standard cee, zee, asymmetrical zee, hat channel, plain channel, single slope eave strut, double slope eave strut, and angle.
2. Thickness: 12 gauge, 0.1046 inch.
3. Finish: Galvanized per ASTM A653/A653M, G90.

C. Framing Connectors: Factory-made formed steel sheet, ASTM A653/A653M SS Grade 50, with G60/Z180 hot dipped galvanized coating and factory punched holes.

2.6 FABRICATION

A. Panels: Provide factory fabricated panels with applied finish and accessory items, using manufacturer's standard processes as required to achieve specified appearance and performance requirements.

B. Joints: Provide captive gaskets, sealants, or separator strips at panel joints to ensure weathertight seals, eliminate metal-to-metal contact, and minimize noise from panel movements.

2.7 FINISHES

A. Fluoropolymer Coil Coating System: Polyvinylidene fluoride (PVDF) multi-coat superior performing organic coatings system complying with AAMA 2605, including at least 70 percent PVDF resin, and at least 80 percent of coil coated aluminum surfaces having minimum total dry film thickness (DFT) of 0.9 mil, 0.0009 inch; color and gloss as selected by Architect from manufacturer’s full line.

2.8 ACCESSORIES

A. Miscellaneous Sheet Metal Items: Provide flashings, gutters, downspouts, trim, moldings, closure strips, caps, and equipment curbs of the same material, thickness, and finish as used for the roofing panels. Items completely concealed after installation may optionally be made of stainless steel.
   1. Flashing to match Metal Composite Material Panels.

B. Rib and Ridge Closures: Provide prefabricated, close-fitting components of steel with corrosion resistant finish.

C. Sealants: Specified in Section 07 92 00 - Joint Sealants.

D. Underlayment: ASTM D226 roofing felt, #30.
   1. Felt caps: As supplied by manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation of preformed metal roof panels until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Broom clean wood sheathing prior to installation of roofing system.

B. Coordinate roofing work with provisions for roof drainage, flashing, trim, penetrations, and other adjoining work to ensure that completed roof will be free of leaks.

C. Remove protective film from surface of roof panels immediately prior to installation; strip film carefully to avoid damage to prefinished surfaces.

D. Separate dissimilar metals by applying a bituminous coating, self-adhering rubberized asphalt sheet, or other permanent method approved by metal roof panel manufacturer.

E. At locations where metal will be in contact with wood or other absorbent material subject to wetting, seal joints with sealing compound and apply one coat of heavy-bodied bituminous paint.

3.3 INSTALLATION

A. Overall: Install roofing system in accordance with approved shop drawings and metal roof panel manufacturer's instructions and recommendations, as applicable to specific project conditions; securely anchor components of roofing system in place allowing for thermal and structural movement.
   1. Install roofing system with concealed clips and fasteners, except as otherwise recommended by manufacturer for specific circumstances.
   2. Minimize field cutting of panels. Where field cutting is required, use methods that will not distort panel profiles. Use of torches for field cutting is prohibited.

B. Accessories: Install all components required for a complete roofing assembly, including flashings, trim, moldings, closure strips, caps, rib closures, ridge closures, and similar roof accessory items.

C. Underlayment:
   1. Install underlayment with 19-inches of overlap minimum.

D. Roof Panels: Install metal roof panels in accordance with manufacturer's installation instructions, minimizing transverse joints except at junction with penetrations.
   1. Form weathertight standing seams incorporating concealed clips, using an automatic mechanical seaming device approved by panel manufacturer.
   2. Provide sealant tape or other approved joint sealer at lapped panel joints.
   3. Install sealant or sealant tape at end laps and side joints as recommended by metal roof panel manufacturer.

3.4 CLEANING

A. Clean exposed sheet metal work at completion of installation. Remove grease and oil films, excess joint sealer, handling marks, and debris from installation, leaving the work clean and unmarked, free from dents, creases, waves, scratch marks, or other damage to the finish.

3.5 PROTECTION

A. Do not permit storage of materials or roof traffic on installed roof panels. Provide temporary walkways or planks as necessary to avoid damage to completed work. Protect roofing until completion of project.

B. Touch-up, repair, or replace damaged roof panels or accessories before Date of Substantial Completion.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect metal roof panel installation, including accessories toward the end of the one year warranty period and toward the end of the Contractor's two year guarantee period. Report results in writing within seven days of each visit.

END OF SECTION 074113

SECTION 074213 - FORMED METAL WALL PANELS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Concealed-fastener, lap-seam metal wall panels.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Meet with Owner, Architect, Owner's insurer if applicable, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of doors, windows, and louvers.
   2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
   4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
   5. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that affect metal panels.
   6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
   7. Review temporary protection requirements for metal panel assembly during and after installation.
   8. Review of procedures for repair of metal panels damaged after installation.
   9. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

B. Shop Drawings:
   1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
   2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.

C. Samples for Initial Selection: For each type of metal panel indicated with factory-applied finishes.
   1. Include Samples of trim and accessories involving color selection.

D. Samples for Verification: For each type of exposed finish, prepared on Samples of size indicated below:
   1. Metal Panels: 12 inches long by actual panel width. Include fasteners, closures, and other metal panel accessories.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

C. Field quality-control reports.

D. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panels to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
   1. Build mockup of typical metal panel assembly as shown on Drawings, including corner, supports, attachments, and accessories.
   2. Water-Spray Test: Conduct water-spray test of metal panel assembly mockup, testing for water penetration according to AAMA 501.2.
   3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Final Acceptance.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal panels during installation.

E. Copper Panels: Wear gloves when handling to prevent fingerprints and soiling of surface.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.10 COORDINATION

A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including rupturing, cracking, or puncturing.
      b. Deterioration of metals and other materials beyond normal weathering.
   2. Warranty Period: Two years from date of Final Acceptance.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
   2. Finish Warranty Period: 20 years from date of Final Acceptance.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592:
   1. Wind Loads: As indicated on Drawings.
   2. Other Design Loads: As indicated on Drawings.
   3. Deflection Limits: For wind loads, no greater than 1/180 of the span.

B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E 283 at the following test-pressure difference:
   1. Test-Pressure Difference: 6.24 lbf/sq. ft.

C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 331 at the following test-pressure difference:
   1. Test-Pressure Difference: 6.24 lbf/sq. ft.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

E. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 CONCEALED-FASTENER METAL WALL PANELS (FMC-1)

A. Metal Wall Panel Systems: Single-skin concealed fastener metal wall panels applied as exterior rainscreen cladding over wall framing specified in Division 05 Section "Cold-Formed Metal Framing" with exterior sheathing specified in Division 06 Section "Sheathing", an applied membrane that provides air, moisture, and water vapor control specified in Division 07 Section "Air Barriers", and insulation within the framing specified in Division 07 Section "Thermal Insulation". Metal wall panel installation specified in this Section includes [secondary metal subgirt framing and] mounting clips for panel attachment.
   1. Air, moisture, and water vapor control membrane is provided under Division 07 Section "Air Barriers."

B. Aluminum Formed Wall Panels (FMP-1): Formed with 87-degree rib angles spaced at alternate intervals across width of panel. Basis of Design Product: PAC-CLAD; Petersen Aluminum Corporation; a Carlisle company, Box Rib 2;
   1. Basis of Design Product: Subject to compliance with requirements, Provide basis of design product or comparable product by one of the following:
      a. Kingspan - Morin Matrix Series.
      b. Central - Concept Series Metal Wall panels.

c. CENTRIA Architectural Systems.
d. MBCI,

2. Panel Thickness:.032 inches.
3. Rib Depth: 1-3/8 inches.
4. Surface Finish: Smooth.
5. Exterior Finish: Two-coat fluoropolymer.
6. Color: As selected by Architect from manufacturer's full range.

2.3 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Sub-framing and Furring: ASTM C 645, cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90 coating designation or ASTM A 792/A 792M, Class AZ50 aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or pre-molded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

2.4 FABRICATION

A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.

C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
   1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
   2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
   3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
   4. Sealed Joints: Form non-expansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
   5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
   6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
      a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

2.5 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Steel Panels and Accessories:
   1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
   1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
   2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.
      a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Supports: Install sub-framing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.

3.3 METAL PANEL INSTALLATION

A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
   1. Shim or otherwise plumb substrates receiving metal panels.
   2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
   3. Install screw fasteners in predrilled holes.
   4. Locate and space fastenings in uniform vertical and horizontal alignment.
   5. Install flashing and trim as metal panel work proceeds.
   6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
   7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
   8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners:
   1. Steel Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.

C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

D. Lap-Seam Metal Panels: Fasten metal panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.
   1. Lap ribbed or fluted sheets one full rib. Apply panels and associated items true to line for neat and weathertight enclosure.
   2. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of metal panels.
   3. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
   4. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.
   5. Flash and seal panels with weather closures at perimeter of all openings.

E. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
   1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal wall panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.

F. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.
   1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof performance.
   2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Water-Spray Test: After installation, test area of assembly as directed by Architect for water penetration according to AAMA 501.2.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed metal wall panel installation, including accessories.

D. Remove and replace metal wall panels where tests and inspections indicate that they do not comply with specified requirements.

E. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

F. Prepare test and inspection reports.

3.5 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074213

SECTION 074213.23 - METAL COMPOSITE MATERIAL WALL PANELS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Exterior cladding consisting of formed metal composite material (MCM) panel with dry seals anchored to panel support framing in a drained and back-ventilated rainscreen application.

B. Panel support framing and mounting clips.

C. Matching flashing and trim.

1.2 RELATED REQUIREMENTS

A. Section 014339 - Mockups.

B. Section 033000 - Cast-in-Place Concrete: Installation of anchors.

C. Section 072500 - Weather Barriers: Weather barrier behind wall panel system.

D. Section 079200 - Joint Sealants: Sealing joints between siding and adjacent construction and fixtures.

1.3 REFERENCE STANDARDS

A. AAMA 509 - Voluntary Test and Classification Method for Drained and Back Ventilated Rain Screen Wall Cladding Systems; 2009.

B. ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes; 2024.

C. ASTM A480/A480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip; 2023b.

D. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2023.

E. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.

F. ASTM D1781 - Standard Test Method for Climbing Drum Peel for Adhesives; 1998 (Reapproved 2021).

G. ASTM D1929 - Standard Test Method for Determining Ignition Temperature of Plastics; 2023.

H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials;

2023d.

I. ASTM E283/E283M - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2019.

J. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference; 2014 (Reapproved 2021).

K. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference; 2000 (Reapproved 2023).

1.4 ADMINISTRATIVE REQUIREMENTS

A. Pre-Installation Meeting: Convene one week before starting work of this section to verify project requirements, coordinate with installers of other work, establish condition and completeness of building substrate, and review manufacturers' installation instructions and warranty requirements.
   1. Require attendance by the installer and relevant sub-contractors.
   2. Include MCM sheet manufacturer’s representative and wall system manufacturer’s representative to review storage and handling procedures.
   3. Review in detail truck transportation, parking, vertical transportation, schedule, personnel, installation of adjacent materials and substrate.
   4. Review procedures for protection of work and other construction.

1.5 SUBMITTALS

A. Product Data - MCM Sheets: Manufacturer's data sheets on each product to be used, including thickness, physical characteristics, and finish, and:
   1. Finish manufacturer's data sheet showing physical and performance characteristics.
   2. Storage and handling requirements and recommendations.
   3. Fabrication instructions and recommendations.
   4. Specimen warranty for finish, as specified herein.

B. Product Data - Wall System: Manufacturer's data sheets on each product to be used, including:
   1. Physical characteristics of components shown on shop drawings.
   2. Storage and handling requirements and recommendations.
   3. Installation instructions and recommendations.
   4. Specimen warranty for wall system, as specified herein.

C. Shop Drawings: Show layout and elevations, dimensions and thickness of panels, connections, details and location of joints, sealants and gaskets, method of anchorage, support clips, concealed fasteners, number of anchors, supports, reinforcement, trim, flashings, and accessories.
   1. Indicate panel numbering system.

2. Differentiate between shop and field fabrication.
3. Indicate substrates and adjacent work with which the wall system must be coordinated.
4. Include large-scale details of anchorages and connecting elements.
5. Include large-scale details or schematic, exploded or isometric diagrams to fully explain flashing at a scale of not less than 1-1/2 inches per 12 inches.
6. Include design engineer's stamp or seal on shop drawings for all components of the wall panel system, including panels, attachments and anchors.

D. Selection Samples: For each finish product specified, submit at least three sample color chips representing manufacturer's standard range of available colors and patterns.
1. Sealant Color: Color to match wall panels.

E. Design Data: Submit structural calculations stamped by design engineer, for Architect's information and project record.

F. Test Report: Submit report of full-size mock-up tests for air infiltration, water penetration, and wind performance.

G. Test Report: Submit report of full-size mock-up tests for wind performance.

H. Manufacturer's Field Reports: Provide within 48 hours of field review. State what was observed and what changes, if any, were requested or required.

I. Maintenance Data: Care of finishes and warranty requirements.

1.6 QUALITY ASSURANCE

A. Field Measurements: Verify actual dimensions of panel framing by field measurement before fabrication; show recorded measurements on shop drawings. Include deviation from prescribed plumbness, squareness and level.

B. Design Engineer's Qualifications: Design structural supports and anchorages under direct supervision of a Structural Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

C. Manufacturer Qualifications: Company specializing in manufacturing wall panel systems specified in this section.
1. With not less than three years of documented experience.

D. Installer Qualifications: Company specializing in performing work of the type specified in this section.
1. With minimum three years of documented experience.
2. Approved by wall panel system manufacturer.

E. Mock-Up: Provide a mock-up for evaluation of fabrication workmanship in accordance with Section 01 43 49.
1. Locate where directed.
2. Provide panels finished as specified.
3. Mock-up may remain as part of the work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in manufacturer's original, unopened, undamaged containers with identification labels intact.
   1. Protect finishes by applying heavy-duty removable plastic film during production.
   2. Package for protection against transportation damage.
   3. Provide markings to identify components consistently with drawings.
   4. Exercise care in unloading, storing, and installing panels to prevent bending, warping, twisting, and surface damage.

B. Store products protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.
   1. Store in well-ventilated space out of direct sunlight.
   2. Protect from moisture and condensation with tarpaulins or other suitable weathertight covering installed to provide ventilation.
   3. Store at a slope to ensure positive drainage of accumulated water.
   4. Do not store in enclosed space where ambient temperature can exceed 120 degrees F.
   5. Avoid contact with other materials that might cause staining, denting, or other surface damage.

1.8 WARRANTY

A. 10 years for MCM quality and bond integrity, and 30 years for 70% PVDF Kynar resin. Warranty begins on date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS:

A. Subject to compliance with requirements, provide Alfrex FR MCM manufactured by an Alfrex, 943 Gainesville Hwy., Bldg100-4000, Buford, GA 30518 USA; comparable product by one of the following:
   1. Alucobond.
   2. Americlad.

2.2 WALL PANEL SYSTEM

A. Wall Panel System: Metal panels, fasteners, and anchors designed to be supported by secondary framing; provide installed panel system capable of maintaining specified performance without defects, damage or failure.
   1. Provide structural design by or under direct supervision of a Structural Engineer licensed in the State in which the Project is located.
   2. Provide panel jointing and weatherseal using a "wet", sealant-sealed system.
   3. Anchor panels to supporting framing without exposed fasteners.

B. PERFORMANCE REQUIREMENTS.
   1. Thermal Movement: Provide for free and noiseless vertical and horizontal thermal movement due to expansion and contraction under material temperature range of minus 20 degrees F to 180 degrees F without buckling, opening of joints, undue stress on fasteners, or other detrimental effects; allow for ambient temperature at time of fabrication, assembly, and erection procedures.
   2. Wind Performance: Provide system tested in accordance with ASTM E330/E330M without permanent deformation or failures of structural members under the following conditions:
      a. Wind Loads and Design Pressures: As indicated on Drawings.
      b. Maximum deflection of perimeter framing member of L/175 normal to plane of the wall; maximum deflection of individual panels of L/60.
   3. Air Leakage: 0.10 cfm/sq ft maximum leakage when tested at 1.57 psf pressure difference in accordance with ASTM E283/E283M.
   4. Water Penetration: No water penetration under static pressure when tested in accordance with ASTM E331 at a differential of 10 percent of inward acting design load, 6.27 psf minimum, after 15 minutes.
      a. Water penetration is defined as the appearance of uncontrolled water on the interior face of the wall.
      b. Design to drain leakage and condensation to the exterior face of the wall.

2.3 MATERIALS

A. Metal Composite Material (MCM) Sheet: continuous process manufactured MCM consisting of an extruded fire-resistant core permanently bonded to pre-finished aluminum skins on each side.
   1. Overall Sheet Thickness: 0.157 inch, minimum.
   2. Face Sheet Thickness: 0.020 inches, minimum.
   3. Alloy: Manufacturer's standard, selected for best appearance and finish durability.
   4. Bond and Peel Strength: No adhesive failure of the bond between the core and the skin nor cohesive failure of the core itself below 22.4 inch-pound/inch with no degradation in bond performance, when tested in accordance with ASTM D1781, simulating resistance to panel delamination, after 8 hours of submersion in boiling water and after 21 days of immersion in water at 70 degrees F.
   5. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
   6. Flammability: Self-ignition temperature of 650 degrees F or greater when tested in accordance with ASTM D1929.
   7. Surface Finish: Smooth.

B. Metal Framing Members: Include all sub-girts (panel supports), zee-clips, base and sill angles and channels, hat-shaped and rigid channels, receptors and furring channels required for complete installation in accordance with Section 05 40 00.
   1. Provide material strength, dimensions, configuration as required to meet the applied loads applied and in compliance with applicable building code.
   2. Aluminum Components: ASTM B209 (ASTM B209M); or ASTM B221 (ASTM B221M).

2.4 FINISHES

A. Factory Finish: Alanod Deco Prime 152 FL 22.

B. Color:
1. Natural Tone (soffit).
2. White; as selected by Architect from manufacturer's standard colors. (wall panel).

2.5 ACCESSORIES

A. Flashing: Sheet aluminum; 0.040 inch thick, minimum; finish and color to match MCM sheet; see Section 07 62 00 for additional requirements.

B. Cladding Support Clips: Thermally-broken, galvanized steel clips for support of cladding z-girts, angles, channels and other framing.

C. Anchors, Clips, and Accessories: Use one of the following:
1. Stainless steel complying with ASTM A276/A276M, ASTM A480/A480M, or ASTM A666.

D. Fasteners:
1. Screws: Self-drilling or self-tapping Type 410 stainless steel or zinc-alloy steel hex washer head, with EPDM or PVC washer under heads of fasteners bearing on weather side of metal wall panels.
2. Bolts: Stainless steel.
3. Fasteners for Flashing and Trim: Blind fasteners of high-strength aluminum or stainless steel.

E. Joint Sealer: Provide color to match wall panels silicone sealant of type approved by MCM sheet manufacturer, and in compliance with ASTM C920.
1. See Section 07 92 00 for additional requirements.

F. Gaskets: Panel manufacturer's EPDM or neoprene, fire-retardant-treated.

G. Provide panel system manufacturer's and installer’s standard corrosion resistant accessories, including fasteners, clips, anchorage devices, and attachments.

H. Extruded Trim: Aluminum, minimum thickness 0.060 inch. Include manufacturer-provided extruded trim, matching panel finish, for the following locations and as indicated on Drawings as metal flashing:
1. Base trim.
2. Panel installation perimeter.
3. Opening perimeters.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine dimensions, tolerances, and interfaces with other work.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

C. Notify Architect in writing of conditions detrimental to proper and timely completion of work, and do not proceed with erection until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect adjacent work areas and finish surfaces from damage during installation.

B. Provide anchorage items to be cast into concrete or built into masonry to appropriate installer(s) together with setting templates.
   1. See Section 03 30 00 for additional cast in place concrete requirements.

3.3 INSTALLATION

A. Do not install products that are defective, including warped, bowed, dented, and broken members, and members with damaged finishes.

B. Comply with instructions and recommendations of MCM sheet manufacturer and wall system manufacturer, as well as with approved shop drawings.

C. Install wall system securely allowing for necessary thermal and structural movement; comply with wall system manufacturer's instructions for installation of concealed fasteners.

D. Do not handle or tool products during erection in manner that damages finish, decreases strength, or results in visual imperfection or failure in performance. Return component parts that require alteration to shop for refabrication, if possible, or for replacement with new parts.

E. Do not form panels in field unless required by wall system manufacturer and approved by the Architect; comply with MCM sheet manufacturer's instructions and recommendations for field forming.

F. Separate dissimilar metals; use gasket fasteners, isolation shims, or isolation tape where needed to eliminate possibility of electrolytic action between metals.

G. Where joints are designed for field-applied sealant, seal joints completely with specified sealant.

H. Install flashings as indicated on shop drawings. At flashing butt joints, provide a lap strap under flashing and seal lapped surfaces with a full bed of non-hardening sealant.

I. Install square, plumb, straight, and true, accurately fitted, with tight joints and intersections maintaining the following installation tolerances:
   1. Variation From Plane or Location: 1/2 inch in 30 feet of length and up to 3/4 inch in 300 feet, maximum.
   2. Deviation of Vertical Member From True Line: 0.1 inch in 25 feet run, maximum.
   3. Deviation of Horizontal Member From True Line: 0.1 inch in 25 feet run, maximum.
   4. Offset From True Alignment Between Two Adjacent Members Abutting End To End, In Line: 0.03 inch, maximum.

J. Replace damaged products.
   1. Exception: Field repairs of minor damage to finishes are permitted only when approved in writing by Architect, panel manufacturer, and fabricator.
   2. Field Repairs to Finishes: Using materials and methods sufficient that repairs are not discernible when viewed at distance of 10 feet under all typical light conditions experienced at the project.

3.4 FIELD QUALITY CONTROL

A. Wall System Manufacturer's Field Services: Provide field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with instructions.

3.5 CLEANING

A. Ensure weep holes and drainage channels are unobstructed and free of dirt and sealants.

B. Remove protective film after installation of joint sealers, after cleaning of adjacent materials, and immediately prior to completion of work.

C. Remove temporary coverings and protection of adjacent work areas.

D. Clean installed products in accordance with manufacturer's instructions.

3.6 PROTECTION

A. Protect installed panel system from damage until Date of Final Acceptance.

END OF SECTION 074213.23

SECTION 074223 - METAL COMPOSITE MATERIAL WALL PANELS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes metal composite material wall panels.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

B. Shop Drawings:
   1. Include fabrication and installation layouts of metal composite material panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment assembly, trim, flashings, closures, and accessories; and special details.
   2. Accessories: Include details of the flashing, trim and anchorage, at a scale of not less than 1-1/2 inches per 12 inches.

C. Samples for Initial Selection: For each type of metal composite material panel indicated with factory-applied color finishes.
   1. Include similar Samples of trim and accessories involving color selection.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
   1. Metal Composite Material Panels: 12 inches long by actual panel width. Include fasteners, closures, and other metal composite material panel accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each product, tests performed by a qualified testing agency.

C. Field quality-control reports.

D. Sample Warranties: For special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal composite material panels to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
   1. Build mockup of typical metal composite material panel assembly as shown on Drawings, including corner, soffits, supports, attachments, and accessories.
   2. Water-Spray Test: Conduct water-spray test of mockup of metal composite material panel assembly, testing for water penetration according to AAMA 501.2.
   3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Final Acceptance.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal composite material panels, and other manufactured items so as not to be damaged or deformed. Package metal composite material panels for protection during transportation and handling.

B. Unload, store, and erect metal composite material panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal composite material panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal composite material panels to ensure dryness, with positive slope for drainage of water. Do not store metal composite material panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal composite material panels during installation.

E. Copper Panels: Wear gloves when handling to prevent fingerprints and soiling of surface.

1.8 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal composite material panels to be performed according to manufacturers' written instructions and warranty requirements.

1.9 COORDINATION

A. Coordinate metal composite material panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal composite material panel systems that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including rupturing, cracking, or puncturing.
      b. Deterioration of metals and other materials beyond normal weathering.
   2. Warranty Period: Two years from date of Final Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal composite material panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
   2. Finish Warranty Period: 20 years from date of Final Acceptance.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal composite material panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 330:
   1. Wind Loads: As indicated on Drawings.
   2. Other Design Loads: As indicated on Drawings.
   3. Deflection Limits: For wind loads, no greater than 1/240 of the span.

B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E 283 at the following test-pressure difference:
   1. Test-Pressure Difference: 6.24 lbf/sq. ft.

C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 331 at the following test-pressure difference:
   1. Test-Pressure Difference: 6.24 lbf/sq. ft.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

E. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

F. Fire Propagation Characteristics: Metal composite material wall panel system passes NFPA 285 testing.

2.2 METAL COMPOSITE MATERIAL WALL PANELS (ACM PANEL)

A. Metal Composite Material Wall Panel Systems: Provide factory-formed and -assembled, metal composite material wall panels fabricated from two metal facings that are bonded to a solid, extruded thermoplastic core; formed into profile for installation method indicated. Include attachment assembly components, panel stiffeners, and accessories required for weathertight system.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Alfrex USA, Anodic Clear Mica or comparable product by one of the following:
      a. Alcoa Architectural Products (USA).
      b. ALUCOBOND; 3A Composites USA, Inc.
      c. Citadel Architectural Products, Inc.
      d. Protean Construction Products, Inc.

B. Aluminum-Faced Composite Wall Panels (MCM): Formed with 0.020-inch- thick, coil-coated aluminum sheet facings.
   1. Panel Thickness: 0.157 inch (4mm).
   2. Core: Standard.
   3. Exterior Finish: Metallic 2-coat fluoropolymer; Mica.
      a. Color: Match Architect's samples.

C. Attachment Assembly Components: Formed from extruded aluminum.

D. Attachment Assembly: Manufacturer's standard.

2.3 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C 645, cold-formed, metallic-coated steel sheet ASTM A 653/A 653M, G90 coating designation or ASTM A 792/A 792M, Class AZ50 aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal composite material panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal composite material panels unless otherwise indicated.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal composite material panels as required to seal against weather and to provide finished appearance.

Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal composite material panels.

D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal composite material panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

E. Panel Sealants: ASTM C 920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal composite material panels and remain weathertight; and as recommended in writing by metal composite material panel manufacturer.

2.4 FABRICATION

A. General: Fabricate and finish metal composite material panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Fabricate metal composite material panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

C. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
   1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
   2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
   3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
   4. Sealed Joints: Form non-expansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
   5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
   6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
      a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

2.5 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Aluminum Panels and Accessories:
   1. Metallic Fluoropolymer: AAMA 2605. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal composite material panel supports, and other conditions affecting performance of the Work.
   1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal composite material wall panel manufacturer.
   2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal composite material wall panel manufacturer.
      a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and assemblies penetrating metal composite material panels to verify actual locations of penetrations relative to seam locations of metal composite material panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal composite material panel manufacturer's written recommendations.

3.3 METAL COMPOSITE MATERIAL PANEL INSTALLATION

A. General: Install metal composite material panels according to manufacturer's written instructions in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to supports unless otherwise indicated. Anchor metal composite material panels and other components of the Work securely in place, with provisions for thermal and structural movement.
   1. Shim or otherwise plumb substrates receiving metal composite material panels.
   2. Flash and seal metal composite material panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal composite material panels are installed.
   3. Install screw fasteners in predrilled holes.
   4. Locate and space fastenings in uniform vertical and horizontal alignment.
   5. Install flashing and trim as metal composite material panel work proceeds.
   6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
   7. Align bottoms of metal composite material panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
   8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners:
   1. Aluminum Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to the interior.

C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal composite material panel manufacturer.

D. Attachment Assembly, General: Install attachment assembly required to support metal composite material wall panels and to provide a complete weathertight wall system, including subgirts, perimeter extrusions, tracks, drainage channels, panel clips, and anchor channels.
   1. Include attachment to supports, panel-to-panel joinery, panel-to-dissimilar-material joinery, and panel-system joint seals.

E. Installation: Attach metal composite material wall panels to supports at locations, spacings, and with fasteners recommended by manufacturer to achieve performance requirements specified.
   1. Rainscreen Systems: Do not apply sealants to joints unless otherwise indicated.

F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
   1. Install components required for a complete metal composite material panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal composite material panel manufacturer; or, if not indicated, provide types recommended in writing by metal composite material panel manufacturer.

G. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.
   1. Install exposed flashing and trim that is without buckling and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof performance.
   2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

3.4 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal composite material wall panel units within installed tolerance of 1/4 inch in 20 feet, non-accumulative, on level, plumb, and location lines as indicated, and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.5 FIELD QUALITY CONTROL

A. Water-Spray Test: After installation, test area of assembly as directed by Architect for water penetration according to AAMA 501.2.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed metal composite material wall panel installation, including accessories.

C. Metal composite material wall panels will be considered defective if they do not pass test and inspections.

D. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

E. Prepare test and inspection reports.

3.6 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal composite material panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal composite material panel installation, clean finished surfaces as recommended by metal composite material panel manufacturer. Maintain in a clean condition during construction.

B. After metal composite material panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

C. Replace metal composite material panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074223

SECTION 075216 - STYRENE-BUTADIENE-STYRENE (SBS) MODIFIED BITUMINOUS MEMBRANE ROOFING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Styrene-butadiene-styrene (SBS)-modified bituminous membrane roofing.
   2. Roof insulation.
   3. Cover board.
   4. Walkways.

B. Section includes the installation of sound-absorbing insulation strips in ribs of roof deck. Sound-absorbing insulation strips are furnished under Section 053100 "Steel Decking."

C. Related Requirements:
   1. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking, and for wood-based, structural-use roof deck panels.
   2. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
   3. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
   4. Section 221423 "Storm Drainage Piping Specialties" for roof drains.

1.3 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D1079 and glossary of NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to Work of this Section.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Roofing Conference: Conduct conference at Project site.
   1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.

2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include plans, sections, details, and attachments to other work, including the following:
1. Layout and thickness of insulation.
2. Base flashings and membrane terminations.
3. Flashing details at penetrations.
4. Tapered insulation, including slopes.
5. Roof plan showing orientation of steel roof deck and orientation of roof membrane, fastening spacings, and patterns for mechanically fastened roofing system.
6. Crickets, saddles, and tapered edge strips, including slopes.
7. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
8. Tie-in with adjoining air barrier.

C. Samples for Verification: For the following products:
1. Cap Sheet: Samples of manufacturer's standard colors for selection by Architect.
2. Flashing Sheet: Samples of manufacturer's standard colors for selection by Architect.
3. Aggregate surfacing material in gradation and color required.
4. Walkway Pads or Rolls: Samples of manufacturer's standard colors for selection by Architect.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, manufacturer and testing agency.

B. Manufacturer Certificates:
1. Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.

C. Product Test Reports: For roof membrane and insulation, tests performed by a qualified testing agency, indicating compliance with specified requirements.

D. Evaluation Reports: For components of membrane roofing system, from ICC-ES.

E. Field quality-control reports.

F. Sample Warranties: For manufacturer's special warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system to include in maintenance manuals.

B. Certified statement from existing roof membrane manufacturer stating that existing roof warranty has not been affected by Work performed under this Section.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is listed in SPRI's Directory of Roof Assemblies for roofing system identical to that used for this Project.

B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.
   1. Protect stored liquid material from direct sunlight.
   2. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources.
   1. Store in a dry location.
   2. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.10 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.
   1. Special warranty includes roof membrane, base flashings, roof insulation, fasteners, cover boards, vapor retarder, substrate board, roof pavers, and other components of roofing system.
   2. Warranty Period: 20 years from date of Final Acceptance.

B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of roofing system such as roof membrane, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarders, roof pavers, and walkway products, for the following warranty period:
   1. Warranty Period: Two years from date of Final Acceptance.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Installed roofing system and flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roof system and flashings shall remain watertight.
   1. Accelerated Weathering: Roof membrane shall withstand 2000 hours of exposure when tested according to ASTM G152, ASTM G154, or ASTM G155.
   2. Impact Resistance: Roof membrane shall resist impact damage when tested according to ASTM D3746/D3746M, ASTM D4272/D4272M, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.

B. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.

C. Wind Uplift Resistance: Design roofing system to resist wind uplift pressures required by the NC State Building Code.

D. Exterior Fire-Test Exposure: ASTM E108 or UL 790, Class A; for application and roof slopes indicated; testing by a qualified testing agency.
   1. Identify products with appropriate markings of applicable testing agency.

2.2 MANUFACTURERS

A. SBS-Modified Bituminous Roofing:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Johns Manville; a Berkshire Hathaway company.
      b. Siplast, Inc.
      c. Soprema.
      d. Firestone Building Products.

B. Source Limitations: Obtain components including roof insulation and fasteners for roofing system from same manufacturer as roofing or manufacturer approved by roofing manufacturer. All products used in the system shall be labeled by the single source roofing manufacturer issuing the guarantee.

2.3 BASE SHEET MATERIALS

A. SBS-Modified Bitumen Fiberglass Mat Base Sheet: ASTM D6164, Type I, Grade S, SBS-modified asphalt sheet, reinforced polyester fabric, smooth surfaced, suitable for cold adhesive application method.

2.4 STYRENE-BUTADIENE-STYRENE (SBS) MODIFIED BITUMINOUS CAP SHEET

A. Granule-Surfaced Roofing Cap Sheet: ASTM D6164/D6164M, Type I, Grade G, SBS-modified asphalt sheet, reinforced with polyester fabric, suitable for cold adhesive application method.
   1. Granule Color: White.

2.5 BASE FLASHING SHEET MATERIALS

A. Backer Sheet: ASTM D6164, Type I or II, Grade S, SBS-modified asphalt sheet, reinforced with polyester fabric, smooth surfaced, suitable for application method specified.

B. Granule-Surfaced Flashing Sheet: ASTM D6164/D6164M, Type I or II, Grade G, SBS-modified asphalt sheet, reinforced with polyester fabric, granule surfaced, suitable for application method specified, and as follows:
   1. Granule Color: White.

2.6 AUXILIARY ROOFING MATERIALS

A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with other roofing components.
   1. Adhesives and Sealants: Comply with VOC limits of authorities having jurisdiction.

B. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.

C. Roof Vents: As recommended by roof membrane manufacturer.
   1. Size: Not less than 4-inch (100-mm) diameter.

D. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.

E. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required by roofing system manufacturer for application.

F. Mastic Sealant: Polyisobutylene, plain or modified bitumen; nonhardening, nonmigrating, nonskinning, and nondrying.

G. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing components to substrate; tested by manufacturer for required pullout strength, and acceptable to roofing system manufacturer.

H. Roofing Granules: Ceramic-coated roofing granules, No. 11 screen size with 100 percent passing No. 8 (2.36-mm) sieve and 98 percent of mass retained on No. 40 (0.425-mm) sieve; color to match roof membrane.

I. Miscellaneous Accessories: Provide those recommended by roofing system manufacturer.

2.7 SUBSTRATE BOARDS

A. Substrate Board: ASTM C1177/C1177M, glass-mat, water-resistant gypsum substrate or ASTM C1278/C1278M, fiber-reinforced gypsum board.
   1. Thickness: 1/2 inch (13 mm).

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

2.8 ROOF INSULATION

A. General: Preformed roof insulation boards, manufactured or approved by roof membrane manufacturer,.

B. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.
   1. Manufacturer: Subject to compliance with requirements, provide products that are manufactured or approved for installation and warranty by the roof system manufacturer.
   2. Compressive Strength: 20 psi (138 kPa).
   3. Size: 48 by 48 inches (1219 by 1219 mm).

C. Tapered Insulation: Provide factory-tapered insulation boards.
   1. Material: Match roof insulation.

2. Minimum Thickness: 1/4 inch (6 mm).
3. Slope:
   a. Roof Field: 1/4 inch per foot (1:48) unless otherwise indicated on Drawings.
   b. Saddles and Crickets: 1/2 inch per foot (1:24) unless otherwise indicated on Drawings.

2.9 INSULATION ACCESSORIES

A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with other roofing system components.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.

C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
   1. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.

D. Insulation Cant Strips: ASTM C728, perlite insulation board.

E. Tapered Edge Strips: ASTM C728, perlite insulation board.

2.10 WALKWAYS

A. Walkway Pads: Reinforced asphaltic composition pads with slip-resisting mineral-granule surface, manufactured as a traffic pad for foot traffic and acceptable to roofing system manufacturer, 1/2 inch (13 mm) thick, minimum.
   1. Pad Size: Approximately 36 by 60 inches (914 mm by 1524 mm).
   2. Color: Contrasting with cap sheet.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
   1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
   2. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
   3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions.
   1. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction.
   1. Remove roof-drain plugs when no work is taking place or when rain is forecast.

3.3 INSTALLATION OF ROOFING, GENERAL

A. Install roofing system according to roofing system manufacturer's written instructions.

B. Complete terminations and base flashings, and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast.
   1. Remove and discard temporary seals before beginning work on adjoining roofing.

C. Install roof membrane and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition and to not void warranty for existing roofing system.

D. Coordinate installation and transition of roofing system component serving as an air barrier with air barrier specified in Section 072726 "Fluid-Applied Membrane Air Barriers."

E. Asphalt Heating: Heat and apply SEBS-modified roofing asphalt according to roofing system manufacturer's written instructions.

F. Substrate-Joint Penetrations: Prevent roofing asphalt and adhesives from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

3.4 INSTALLATION OF INSULATION

A. Coordinate installing roofing system components, so insulation is not exposed to precipitation or left exposed at the end of the workday.

B. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.

C. Insulation Cant Strips: Install and secure preformed 45-degree insulation cant strips at junctures of roofing system with vertical surfaces or angle changes greater than 45 deg F (14 deg C).

D. Installation Over Metal Decking:
   1. Install base layer of insulation with joints staggered not less than 24 inches (600 mm) in adjacent rows.
      a. Locate end joints over crests of decking.
      b. Where installing composite and non-composite insulation in two or more layers, install non-composite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
      c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
      d. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.
      e. At internal roof drains, slope insulation to create a square drain sump, with each side equal to the diameter of the drain bowl plus 24 inches (600 mm).
         1) Trim insulation, so that water flow is unrestricted.
      f. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
      g. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
      h. Mechanically attach base layer of insulation using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to metal decks.
         1) Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.
   2. Install upper layers of insulation and tapered insulation, with joints of each layer offset not less than 12 inches (300 mm) from previous layer of insulation.
      a. Install with long joints continuous and with end joints staggered not less than 12 inches (300 mm) in adjacent rows.
      b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
      c. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.
      d. At internal roof drains, slope insulation to create a square drain sump, with each side equal to the diameter of the drain bowl plus 24 inches (600 mm).
      e. Trim insulation, so that water flow is unrestricted.
      f. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
      g. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
      h. Adhere each layer of insulation to substrate using adhesive as follows:
         1) Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.

3.5 INSTALLATION OF COVER BOARDS

A. Install cover boards over insulation with long joints in continuous straight lines, with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction.
   1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
   2. At internal roof drains, conform to slope of drain sump.

a. Trim cover board, so that water flow is unrestricted.

3. Cut and fit cover board tight to nailers, projections, and penetrations.
4. Adhere cover board to substrate using adhesive according to and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
   a. Set cover board in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.

B. Install sheathing paper over cover board and immediately beneath roof membrane.

3.6 INSTALLATION OF ROOFING MEMBRANE, GENERAL

A. Install roofing system according to roofing system manufacturer's written instructions and applicable recommendations in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing."
   1. Membrane: MBS (SBS).
   2. Adhering Method: T (torched).
   3. Base Sheet: One.
   4. Number of Modified Asphalt Sheets: One.
   5. Surfacing Type: M (mineral-granule-surfaced cap sheet).

B. Start installation of roofing in presence of roofing system manufacturer's technical personnel.

C. Coordinate installation of roofing system so insulation and other components of the roofing system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.
   1. Provide tie-offs at end of each day's work to cover exposed roofing sheets and insulation with a course of coated felt set in roofing cement or hot roofing asphalt, with joints and edges sealed.
   2. Complete terminations and base flashings, and provide temporary seals to prevent water from entering completed sections of roofing system.
   3. Remove and discard temporary seals before beginning work on adjoining roofing.

3.7 INSTALLATION OF BASE SHEET

A. Before installing, unroll base sheet, cut into workable lengths, and allow to lie flat for a time period recommended by manufacturer for the ambient temperature.

B. Install glass-fiber base-ply sheets according to roofing system manufacturer's written instructions starting at low point of roofing system. Align glass-fiber base-ply sheets without stretching. Extend glass-fiber base-ply sheets over and terminate beyond cants. Embed each glass-fiber base-ply sheet in a continuous void-free mopping of hot roofing asphalt, to form a uniform membrane without glass-fiber base-ply sheets touching.

3.8 INSTALLATION OF SBS-MODIFIED BITUMINOUS CAP SHEET

A. Install modified bituminous roofing sheet and cap sheet according to roofing manufacturer's written instructions, starting at low point of roofing system. Extend roofing sheets over and terminate beyond cants.
   1. Unroll roofing sheets and allow them to relax for minimum time period required by manufacturer.

B. Laps: Accurately align roofing sheets, without stretching, and maintain uniform side and end laps. Stagger end laps. Completely bond and seal laps, leaving no voids.
   1. Repair tears and voids in laps and lapped seams not completely sealed.
   2. Apply roofing granules to cover exuded bead at laps while bead is hot.

C. Install roofing sheets so side and end laps shed water.

3.9 INSTALLATION OF FLASHING AND STRIPPING

A. Install base flashing over cant strips and other sloped and vertical surfaces, at roof edges, and at penetrations through roof, and secure to substrates according to roofing system manufacturer's written instructions and as follows:
   1. Prime substrates with asphalt primer if required by roofing system manufacturer.
   2. Backer Sheet Application:
      a. Mechanically fasten backer sheet to walls or parapets.
      b. Adhere backer sheet over roofing membrane at cants in a solid mopping of hot roofing asphalt.
      c. Seal all laps.
   3. Flashing Sheet Application: Adhere flashing sheet to substrate in a solid mopping of hot roofing asphalt applied at asphalt temperature recommended by flashing sheet manufacturer. Apply hot roofing asphalt to back of flashing sheet if recommended by roofing system manufacturer.

B. Extend base flashing up walls or parapets a minimum of 8 inches (200 mm) above roofing membrane and 4 inches (100 mm) onto field of roofing membrane.

C. Mechanically fasten top of base flashing securely at terminations and perimeter of roofing.
   1. Seal top termination of base flashing.

D. Install roofing cap-sheet stripping where metal flanges and edgings are set on roofing according to roofing system manufacturer's written instructions.

E. Roof Drains: Set 30-by-30-inch- (760-by-760-mm-) 4-pound (1.8 kg) lead flashing in bed of asphaltic adhesive on completed roofing membrane.
   1. Cover lead flashing with roofing cap-sheet stripping, and extend a minimum of 6 inches (150 mm) beyond edge of metal flashing onto field of roofing membrane.
   2. Clamp roofing membrane, metal flashing, and stripping into roof-drain clamping ring.
   3. Install stripping according to roofing system manufacturer's written instructions.

3.10 INSTALLATION OF WALKWAYS

A. Walkway Pads: Install walkway pads using units of size indicated or, if not indicated, of manufacturer's standard size, according to walkway pad manufacturer's written instructions.
   1. Install walkways at the following locations:
      a. Perimeter of each rooftop unit.
      b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
      c. Top and bottom of each roof access ladder.
      d. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
      e. As required by roof membrane manufacturer's warranty requirements.
   2. Provide 3-inch (76-mm) clearance between adjoining pads.
   3. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to inspect substrate conditions, surface preparation, roof membrane application, flashings, protection, and drainage components, and to furnish reports to Architect.

B. Test Cuts: Remove test specimens to evaluate problems observed during quality-assurance inspections of roofing membrane as follows:
   1. Determine approximate quantities of components within roofing membrane according to ASTM D3617/D3617M.
   2. Examine test specimens for interply voids according to ASTM D3617/D3617M and to comply with criteria established in Appendix 3 of ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing."
   3. Repair areas where test cuts were made according to roofing system manufacturer's written instructions.

C. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report.
   1. Notify Architect and Owner 48 hours in advance of date and time of inspection.

D. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

E. Roofing system will be considered defective if it does not pass tests and inspections.
   1. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.12 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period.
   1. When remaining construction does not affect or endanger roofing, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Final Acceptance and according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.13 ROOFING INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following project:
   1. Owner: North Carolina Museum of Art; Department of Natural and Cultural Resources.
   2. Address: 2110 Blue Ridge Road, Raleigh, NC 27607.
   3. Building Name/Type: North Carolina Museum of Art East Building.
   4. Address: 2110 Blue Ridge Road, Raleigh, NC 27607.
   5. Area of Work: <Insert information>.
   6. Acceptance Date: _____.
   7. Warranty Period: Two years from date of Final Acceptance.
   8. Expiration Date: _____.

B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period Roofing Installer will, at Roofing Installer's own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:
   1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:
      a. lightning.
      b. peak gust wind speed per structural drawings.
      c. fire;
      d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;

e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
f. vapor condensation on bottom of roofing; and.
g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.

2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
4. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.
6. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.
1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 075216

SECTION 075423 - THERMOPLASTIC-POLYOLEFIN ROOFING (TPO)

PART 1 GENERAL

1.1 SECTION INCLUDES

A. TPO membrane roofing system and accessories.

B. Cover board.

C. Insulation.

D. Deck sheathing.

E. Metal accessories.

1.2 RELATED REQUIREMENTS

A. Section 077200 - Roof Accessories: Manufactured copings, fascias, gravel stops, and other flashing-related items.

1.3 REFERENCE STANDARDS

A. ANSI/SPRI/FM 4435/ES-1 - Test Standard for Edge Systems Used with Low Slope Roofing Systems; 2017.

B. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2019.

C. ASTM C209 - Standard Test Methods for Cellulosic Fiber Insulating Board; 2020.

D. ASTM C473 - Standard Test Methods for Physical Testing of Gypsum Panel Products; 2019.

E. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.

F. ASTM C1177/C1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing; 2017.

G. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2023a.

H. ASTM C1549 - Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer; 2016.

I. ASTM D638 - Standard Test Method for Tensile Properties of Plastics; 2022.

J. ASTM D1004 - Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting; 2013.

K. ASTM D1621 - Standard Test Method for Compressive Properties of Rigid Cellular Plastics; 2016 (Reapproved 2023).

L. ASTM D1622 - Standard Test Method for Apparent Density of Rigid Cellular Plastics; 2020.

M. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber; 2021.

N. ASTM D6878/D6878M - Standard Specification for Thermoplastic Polyolefin-Based Sheet Roofing; 2021.

O. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.

P. ASTM E136 - Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C; 2024.

Q. FM (AG) - FM Approval Guide; current edition.

R. NRCA (RM) - The NRCA Roofing Manual; 2022.

S. PS 1 - Structural Plywood; 2023.

T. PS 20 - American Softwood Lumber Standard; 2021.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate with installation of associated counter flashings and roof drainage components installed under other sections.

B. Preinstallation Meeting: Convene one week before starting work of this section.
   1. Require attendance of parties directly influencing roofing work quality or affected by roofing work performance.

1.5 SUBMITTALS

A. Product Data:
   1. Provide membrane manufacturer's printed data showing roofing system components, including insulation and fasteners, comply with specified requirements and with membrane manufacturer's requirements and recommendations for system type specified; include data for each product used in conjunction with roofing membrane.
   2. Where UL or FM requirements are specified, provide documentation showing roofing

system is UL classified or FM approved, as applicable; include data-itemizing components of classified or approved system.

3. Installation Instructions: Provide manufacturer's instructions to installer, marked up to show how components will be installed; where instructions allow installation options, clearly indicate which option will be used.

B. Shop Drawings: Indicate membrane manufacturer's standard details, drawn to scale and customized for project for relevant conditions.
   1. For tapered insulation, indicate project-specific layout, slopes, thicknesses, and dimensions.

C. Samples: Submit samples of each product to be used.

D. Preinstallation Notice: Provide copy of manufacturer's approved preinstallation notice.

E. Installer's qualification statement.

F. Executed warranty.

G. Specimen Warranty: Submit prior to starting work.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing work of this section with minimum five years of documented experience installing specified system.

B. Trained and certified in installing manufacturer's product.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in manufacturer's original containers, dry and undamaged, with seals and labels intact and legible.

B. Store materials clear of ground and moisture with weather-protective covering.

C. Keep combustible materials away from ignition sources.

1.8 FIELD CONDITIONS

A. Do not apply roofing membrane during unsuitable weather or when ambient conditions conflict with manufacturer's installation instructions.

B. Schedule applications so no partially completed sections of roof are left exposed at end of workday.

1.9 WARRANTY

A. See Section 017700 - Closeout Procedures for additional warranty requirements.

B. Comply with warranty procedures required by manufacturer, including notifications, scheduling, and inspections.

C. System Warranty: Manufacturer's limited warranty covering membrane, roof insulation, and other specified system components for term indicated.
   1. Liability Limit: No dollar limitation.
   2. Scope of Coverage: Repair leaks in roofing system caused by:
      a. Ordinary wear and tear of elements.
      b. Manufacturing defect in Elevate brand materials.
      c. Defective workmanship used to install materials.
      d. Damage due to winds up to 55 mph.
   3. Not Covered:
      a. Damage to winds in excess of specified speed.
      b. Damage due to hurricanes or tornadoes.
      c. Hail.
      d. Intentional damage.
      e. Unintentional damage due to normal rooftop inspections, maintenance, or service.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Membrane Roofing System:
   1. Basis of design: Elevate Roofing, Wall, and Lining Systems: www.holcimelevate.com/#sle.
   2. Other manufacturers:
      a. GAF.
      b. Carlisle.
      c. IKO.

B. Insulation Manufacturer: Same manufacturer as roof membrane.

C. Metal Roof Edging Manufacturer: Same manufacturer as roof membrane.
   1. Field- or shop-fabricated metal roof edgings are unacceptable.

2.2 MEMBRANE ROOFING SYSTEM

A. Description: TPO single-ply membrane.
   1. Membrane Attachment: Mechanically fastened.
   2. Warranty: Full system warranty; 20-year Red Shield limited warranty covering membrane, roof insulation, and membrane accessories.
   3. Deck Slope: Flat; provide slope of 1/8 inch per foot by means of tapered insulation.
   4. Comply with applicable local building code requirements.

a. Design Wind Speed: In accordance with local building code and authorities having jurisdiction (AHJ).

5. Provide assembly having Underwriters Laboratories, Inc. (UL) Class B fire hazard classification.

B. Roofing System Components: Listed in order from top of roof down:
1. Membrane: Thickness as specified.
2. Cover Board: High-density polyisocyanurate; 1/2 inch thick; adhered.
3. Insulation:
a. Tapered: Minimum slope as indicated; provide minimum R-value at thinnest point; place tapered layer on top or on bottom.
b. Total System R-value: 30, minimum.
4. Deck Sheathing: Gypsum-based board, 1/2 inch thick; mechanically fastened.

2.3 MEMBRANE MATERIALS

A. Membrane: Flexible, heat-weldable sheet composed of TPO polymer and ethylene propylene rubber; complying with ASTM D6878/D6878M, with polyester weft-inserted reinforcement and the following additional characteristics:
1. Thickness: 0.06 inch plus/minus 10 percent, with coating thickness over reinforcement of 0.024 inch plus/minus 10 percent.
2. Solar Reflectance: 0.79, minimum, when tested in accordance with ASTM C1549.
3. Color: White.
4. Products:

B. Membrane Fasteners: Type and size required and furnished by by roof membrane manufacturer for roofing system and warranty.

C. Curb and Parapet Flashing: Same material as membrane, with encapsulated edge eliminating need for seam sealing flashing-to-roof splice; precut to 18 inches wide.

D. Formable Flashing: Nonreinforced, flexible, heat-weldable sheet, composed of TPO polymer and ethylene propylene rubber.
1. Thickness: 0.06 inch plus/minus 10 percent.
2. Tensile Strength: 1,550 psi, minimum, when tested in accordance with ASTM D638 after heat aging.
3. Elongation at Break: 650 percent, minimum, when tested in accordance with ASTM D638 after heat aging.
4. Tearing Strength: 12 lbf, minimum, when tested in accordance with ASTM D1004 after heat aging.
5. Product: As recommended by manufacturer.

E. Bonding Adhesive: Manufacturer's recommended bonding adhesive formulated for compatibility with membrane and other substrate materials, including masonry, wood, and insulation facings.

F. Pourable Sealer: Manufacturer's recommended two-part polyurethane, two-color for reliable mixing.

G. Cut Edge Sealant: Use manufacturer's recommended sealant for exposed membrane reinforcement.

H. General Purpose Sealant: Manufacturer's recommended, one part, white.

I. Molded Flashing Accessories: Unreinforced TPO membrane premolded to suit variety of flashing details, including pipe boots, inside corners, outside corners, etc.
   1. Product: Manufacturer's standard.

J. Termination Bars: Aluminum bars with integral caulk ledge; 1.3 inches wide by 0.1 inch thick.
   1. Product: Elevate; Termination Bar.

2.4 COVER BOARDS

A. High-Density Polyisocyanurate Cover Board: Water-resistant, high-density, closed-cell polyisocyanurate core with coated glass mat facers complying with ASTM C1289, Type II, Class 4, and the following characteristics:
   1. Thermal Value: R-value of 2.5, when tested in accordance with ASTM C518 and ASTM C177.
   2. Surface Water Absorption by Volume: 3 percent, maximum, when tested in accordance with ASTM C209.
   3. Compressive Strength: Grade 1, 120 psi, when tested in accordance with ASTM D1621.
   4. Density: 5 pcf, when tested in accordance with ASTM D1622.
   5. Factory Mutual approved for use with FM 1-60 and 1-90 rated roofing assemblies.
   6. Mold Growth Resistance: Passing ASTM D3273.
   7. Product: Elevate; ISOGARD HD Cover Board.

2.5 INSULATION

A. Polyisocyanurate Board Insulation: Closed-cell polyisocyanurate foam laminated to facers, complying with ASTM C1289, Type II, Class 1, with the following additional characteristics:
   1. Compressive Strength: 20 psi when tested in accordance with ASTM D1621.
   2. Ozone Depletion Potential: Zero; made without CFC- or HCFC-blowing agents.
   3. Recycled Content: 19 percent post-consumer and 15 percent pre-consumer (post-industrial), average.

2.6 DECK SHEATHING

A. Gypsum-Based Deck Sheathing: Noncombustible, water-resistant gypsum core with embedded glass mat facers, complying with ASTM C1177/C1177M, with the following additional characteristics:
   1. Water Absorption: 10 percent maximum, when tested in accordance with ASTM C473.
   2. Spanning Capability: Recommended by manufacturer for the following minimum flute spans:
      a. 1/4-inch Thickness: 2-5/8 inches, minimum.
   3. Surface Burning Characteristics: Flame spread index of 0, smoke developed index of 0, when tested in accordance with ASTM E84.

4. Combustibility: Noncombustible, when tested in accordance with ASTM E136.
5. Factory Mutual approved for use with FM 1-60 and 1-90 rated roofing assemblies.
6. Mold Growth Resistance: Zero growth, when tested in accordance with ASTM D3273 for minimum of four weeks.

2.7 METAL ACCESSORIES

A. Metal Roof Edging and Fascia: Continuous metal edge member serving as termination of roof membrane and retainer for metal fascia; watertight with no exposed fasteners; mounted to roof edge nailer.
   1. Wind Performance:
      a. Membrane Pull-Off Resistance: 100 lb/ft, minimum, when tested in accordance with ANSI/SPRI/FM 4435/ES-1 using test method RE-1.
      b. Fascia Pull-Off Resistance: At least the minimum required when tested in accordance with ANSI/SPRI/FM 4435/ES-1 using test method RE-2.
      c. Provide product listed in FM (AG) with at least FM 1-270 rating.
   2. Fascia Face Height: 5 inches.
   3. Length: 144 inches.
   4. Anchor Bar Cleat: 20-gauge, 0.036-inch galvanized steel with prepunched holes.
   5. Fasteners: Factory-provided corrosion-resistant fasteners, with drivers; do not permit exposed fasteners.

2.8 ACCESSORIES

A. Wood Nailers: PS 20 dimension lumber, Structural Grade No. 2 or better Southern Pine, Douglas Fir; or PS 1, APA Exterior Grade plywood; pressure preservative treated.
   1. Do not use asphaltic or creosote-treated lumber.
   2. Do not use lumber treated with wood preservatives, such as pentachlorophenol, copper naphthenate, or copper 8-quinolinolate.
   3. Width: 3-1/2 inches, nominal minimum, or as wide as nailing flange of roof accessory attached.
   4. Thickness: Same as thickness of roof insulation.

PART 3 EXECUTION

3.1 GENERAL

A. Install roofing, insulation, flashings, and accessories in accordance with roofing manufacturer's published instructions and recommendations for specified roofing system. Where manufacturer provides no instructions or recommendations, follow NRCA (RM) written requirements and industry standards. Comply with federal, state, and local regulations.

B. Obtain relevant instructions and maintain copies at project site for duration of installation period.

C. Do not start work until preinstallation notice has been submitted to manufacturer.

D. Provide temporary closures to ensure moisture does not damage completed roofing. Use flashings, terminations, and temporary closures to provide watertight installation.

E. Protect adjacent construction, property, vehicles, and persons from damage related to roofing work; repair or restore damage caused by roofing work.
   1. Protect from spills and overspray from bitumen, adhesives, sealants, and coatings.
   2. Protect metal, glass, plastic, and painted surfaces from bitumen, adhesives, and sealants within range of windborne overspray.
   3. Protect finished areas of roofing system from roofing-related work traffic and traffic by other trades.

3.2 EXAMINATION

A. Examine roof deck to determine deck is sufficiently rigid to support installers and mechanical equipment so deflection will not strain or rupture roof components or deform deck.

B. Verify surfaces and site conditions are ready to receive work. Correct defects in substrate before commencing with roofing work.

C. Examine roof substrate to verify adequate slope to drains.

D. Verify specifications and drawing details are workable and not in conflict with roofing manufacturer's recommendations and instructions; start of work constitutes acceptable project conditions and requirements.

3.3 PREPARATION

A. Take appropriate measures to ensure fumes from adhesive solvents are not drawn into building through air intakes.

B. Before proceeding, ensure roof surface is clean, dry, and smooth and free of sharp edges, fins, roughened surfaces, loose or foreign materials, oil, grease, and other materials that may damage membrane.

C. Fill surface voids in immediate substrate greater than 1/4-inch wide with fill material acceptable insulation to membrane manufacturer.

3.4 METAL DECK PREPARATION

A. Install deck sheathing on metal deck.
   1. Lay with long side at right angle to flutes; stagger end joints; provide support at ends.
   2. Cut and install deck sheathing to provide smooth and flat surface.
   3. Adhere deck sheathing to roof deck with continuous mopping of adhesive.

3.5 INSULATION INSTALLATION

A. Install insulation in accordance with manufacturer's written instructions.

B. Install only as much insulation as can be covered with completed roofing system before end of day's work or before onset of inclement weather.

C. Lay roof insulation in courses parallel to roof edges.

D. Neatly and tightly fit insulation to penetrations, projections, and nailers, with gaps not greater than 1/4 inch. Fill gaps greater than 1/4 inch with manufacturer's recommended insulation. Do not leave roofing membrane unsupported over space greater than 1/4 inch.

3.6 COVER BOARD INSTALLATION

A. Install in accordance with membrane manufacturer's instructions and recommendations.

3.7 SINGLE-PLY MEMBRANE INSTALLATION

A. Beginning at low point of roof, place membrane without stretching over substrate and allow to relax before attachment or splicing. Refer to membrane manufacturer's guidelines for minimum relaxation time.

B. Lay out membrane pieces so field and flashing splices are installed to shed water.

C. Install membrane without wrinkles and without gaps or fishmouths in seams; bond and test seams and laps in accordance with membrane manufacturer's instructions and details.

D. Mechanical Attachment:
   1. Lay out plates and fasteners as recommended by membrane manufacturer.
   2. Install fasteners in deck with heads flush in accordance with manufacturer's instructions.

E. Edge Securement: Secure membrane at locations where membrane terminates or goes through angle change greater than 2 in 12 inches using mechanically fastened reinforced perimeter fastening strips, plates, or metal edging as indicated or as recommended by roofing manufacturer.
   1. Exceptions: Round pipe penetrations less than 18 inches in diameter and square penetrations less than 4 inches wide.

3.8 FLASHING AND ACCESSORIES INSTALLATION

A. Install flashings, including laps, splices, joints, bonding, adhesion, and attachment, as required by membrane manufacturer's recommendations and details.

B. Metal Accessories: Install metal edgings and copings in locations indicated on drawings, with horizontal leg of edge member over membrane and flashing over metal onto membrane.
   1. Follow roofing manufacturer's instructions.

2. Remove protective plastic surface film immediately before installation.
3. Install water block sealant under membrane anchorage leg.
4. Flash with manufacturer's recommended flashing sheet unless otherwise indicated.
5. Where single application of flashing will not completely cover metal flange, install additional piece of flashing to cover metal edge.
6. If roof edge includes gravel stop and sealant is not applied between laps in metal edging, install additional piece of self-adhesive flashing membrane over metal lap to top of gravel stop; apply seam edge treatment at intersections of two flashing sections.
7. When roof slope is greater than 1:12, apply seam edge treatment along back edge of flashing.

C. Scuppers: Set in sealant and secure to structure; flash as recommended by manufacturer.

D. Roofing Expansion Joints: Install as shown on drawings and as recommended by roofing manufacturer.

E. Flashing at Walls, Curbs, and Other Vertical and Sloped Surfaces: Install weathertight flashing at walls, curbs, parapets, curbs, skylights, and other vertical and sloped surfaces.
1. Extend flashing minimum 8 inches above membrane surface unless otherwise shown.
2. Use longest practical flashing pieces.
3. Evaluate substrate and overlay and adjust installation procedure in accordance with membrane manufacturer's recommendations.
4. Complete splices between flashing and main roof sheet with specified splice adhesive before adhering flashing to vertical surfaces.

F. Roof Drains:
1. Taper insulation around drain to provide smooth transition from roof surface to drain. Use specified premanufactured tapered insulation with facer or suitable bonding surface to achieve slope; slope not to exceed manufacturer's recommendations.
2. Position membrane, then cut hole for roof drain to allow 1/2 to 3/4 inch of membrane to extend inside clamping ring past drain bolts.
3. Make round holes in membrane to align with clamping bolts; do not cut membrane back to bolt holes.
4. Apply sealant on top of drain bowl where clamping ring seats below membrane.
5. Install roof drain clamping ring and clamping bolts; tighten clamping bolts to achieve constant compression.

G. Flashing at Penetrations: Flash penetrations passing through membrane; make flashing seals directly to penetration.
1. Pipes, Round Supports, and Similar Items: Flash with specified premolded pipe flashings wherever practical; otherwise, use specified self-curing elastomeric flashing.
2. Pipe Clusters and Unusual Shaped Penetrations: Provide penetration pocket at least 2 inches deep, with at least 1-inch clearance from penetration; fill with manufacturer's pourable sealer, and slope to shed water.
3. Structural Steel Tubing: If corner radii are greater than 1/4 inch and longest side of tube does not exceed 12 inches, flash as for pipes; otherwise, provide standard curb with flashing.
4. Flexible and Moving Penetrations: Provide weathertight gooseneck set in sealant and secured to deck, flashed as recommended by manufacturer.

3.9 CLEANING

A. Clean contaminants generated by roofing work from building and surrounding areas, including bitumen, adhesives, sealants, and coatings.

B. Repair or replace building components and finished surfaces damaged or defaced due to work of this section; comply with recommendations of manufacturers of components and surfaces.

C. Remove leftover materials, trash, debris, and equipment from project site and surrounding areas.

3.10 PROTECTION

A. Where construction traffic continues over finished roof panels, provide durable protection and replace or repair damaged roofing to original condition.

END OF SECTION 075423

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Manufactured reglets with counterflashing.
   2. Manufactured through-wall flashing with counterflashing.
   3. Formed roof-drainage sheet metal fabrications.
   4. Formed low-slope roof sheet metal fabrications.
   5. Formed wall fabrications: Including through-wall flashing and opening flashings in frame construction.

B. Related Requirements:
   1. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.
   2. Section 042000 "Unit Masonry" for materials and installation of manufactured sheet metal through-wall flashing and trim integral with masonry.
   3. Section 074213 "Metal Wall Panels" for sheet metal flashing and trim integral with metal wall panels.
   4. Section 077200 "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.

1.3 COORDINATION

A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.

B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   2. Review special roof details, roof drainage, roof-penetration flashing, equipment curbs, and condition of other construction that affect sheet metal flashing and trim.
   3. Review requirements for insurance and certificates if applicable.

4. Review sheet metal flashing observation and repair procedures after flashing installation.

1.5 ACTION SUBMITTALS

A. Product Data: For each of the following:
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.
      a. Underlayment materials.
      b. Elastomeric sealant.
      c. Butyl sealant.
      d. Epoxy seam sealer.

B. Shop Drawings: For sheet metal flashing and trim.
   1. Include plans, elevations, sections, and attachment details.
   2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.
   3. Include identification of material, thickness, weight, and finish for each item and location in Project.
   4. Include details for forming, including profiles, shapes, seams, and dimensions.
   5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
   6. Include details of termination points and assemblies.
   7. Include details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
   8. Include details of roof-penetration flashing.
   9. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, flashings, and counterflashings.
   10. Include details of special conditions.
   11. Include details of connections to adjoining work.
   12. Detail formed flashing and trim at scale of not less than 1-1/2 inches per 12 inches (1:10).

C. Samples for Initial Selection: For each type of sheet metal and accessory indicated with factory-applied finishes.

D. Samples for Verification: For each type of exposed finish.
   1. Sheet Metal Flashing: 12 inches (300 mm) long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.
   2. Trim, Metal Closures, Expansion Joints, Joint Intersections, and Miscellaneous Fabrications: 12 inches (300 mm) long and in required profile. Include fasteners and other exposed accessories.
   3. Unit-Type Accessories and Miscellaneous Materials: Full-size Sample.
   4. Anodized Aluminum Samples: Samples to show full range to be expected for each color required.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

B. Product Certificates: For each type of coping and roof edge flashing that is SPRI ES-1 tested and FM Approvals approved.

C. Product Test Reports: For each product, for tests performed by a qualified testing agency.

D. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sheet metal flashing and trim, and its accessories, to include in maintenance manuals.

B. Special warranty.

1.8 QUALITY ASSURANCE

A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
   1. For copings and roof edge flashings that are ANSI/SPRI/FM 4435/ES-1 tested and FM Approvals approved, shop shall be listed as able to fabricate required details as tested and approved.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
   1. Build mockup of typical roof edge eave, including built-in gutter and fascia trim, approximately 10 feet (3.0 m) long, including supporting construction cleats, seams, attachments, underlayment, and accessories.
   2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations in writing.
   3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Final Acceptance.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.
   1. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
   2. Protect stored sheet metal flashing and trim from contact with water.

B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.10 WARRANTY

A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
      b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
   2. Finish Warranty Period: 20 years from date of Final Acceptance.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. SPRI Wind Design Standard: Manufacture and install copings and roof edge flashings tested in accordance with ANSI/SPRI/FM 4435/ES-1 and capable of resisting the following design pressure:
   1. Design Pressure: As indicated on Drawings.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 SHEET METALS

A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Aluminum Sheet: ASTM B209 (ASTM B209M), alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required; with smooth, flat surface.
   1. Clear Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

2. Exposed Coil-Coated Finish:
    a. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
3. Color: Custom color to match adjacent metal as approved by Architect.
4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.

C. Stainless Steel Sheet: ASTM A240/A240M, Type 304, dead soft, fully annealed; with smooth, flat surface.
1. Finish: ASTM A480/A480M, No. 2D (dull, cold rolled).
    a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
    b. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
        1) Run grain of directional finishes with long dimension of each piece.
        2) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

D. Metallic-Coated Steel Sheet: Provide zinc-coated (galvanized) steel sheet in accordance with ASTM A653/A653M, G90 (Z275) coating designation; prepainted by coil-coating process to comply with ASTM A755/A755M.
1. Surface: Smooth, flat.
2. Exposed Coil-Coated Finish:
    a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
3. Color: Custom color to match adjacent metal as approved by Architect.
4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.

2.3 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, solder, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
    a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under

heads of exposed fasteners bearing on weather side of metal.
b. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.
c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
3. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
4. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329.

C. Solder:
1. For Stainless Steel: ASTM B32, Grade Sn60, with acid flux of type recommended by stainless steel sheet manufacturer.
2. For Zinc-Coated (Galvanized) Steel: ASTM B32, with maximum lead content of 0.2 percent.

D. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, non-sag, nontoxic, non-staining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.

E. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

F. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

G. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.

H. Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D1187/D1187M.

I. Reglets: Units of type, material, and profile required, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory-mitered and -welded corners and junctions and with interlocking counterflashing on exterior face, of same metal as reglet.
1. HYPERLINK "http://www.specagent.com/Lookup?ulid=5151" Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Cheney Flashing Company.
b. Fry Reglet Corporation.
c. Heckmann Building Products, Inc.
d. Hohmann & Barnard, Inc.
e. Keystone Flashing Company, Inc.
f. National Sheet Metal Systems, Inc.
2. Source Limitations: Obtain reglets from single source from single manufacturer.
3. Material: Aluminum, 0.024 inch (0.61 mm) thick.

4. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
5. Concrete Type: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
6. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
7. Accessories:
   a. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.
   b. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing's lower edge.
8. Finish: With manufacturer's standard color coating.

2.4 FABRICATION, GENERAL

A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.
   1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
   2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
   3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
   4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
   5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Fabrication Tolerances:
   1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines indicated on Drawings and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.
   2. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified.

C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
   1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with butyl sealant concealed within joints.
   2. Use lapped expansion joints only where indicated on Drawings.

D. Sealant Joints: Where movable, non-expansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.

E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

F. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard for application, but not less than thickness of metal being secured.

G. Seams:
1. Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
2. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.
3. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints where necessary for strength.

H. Do not use graphite pencils to mark metal surfaces.

2.5 ROOF-DRAINAGE SHEET METAL FABRICATIONS

A. Downspouts: Fabricate rectangular downspouts to dimensions indicated on Drawings, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors. Shop fabricate elbows.
1. Fabricate from the following materials:
a. Aluminum: 0.024 inch (0.61 mm) thick.

B. Parapet Scuppers: Fabricate scuppers to dimensions required, with closure flange trim to exterior, 4-inch- (100-mm-) wide wall flanges to interior, and base extending 4 inches (100 mm) beyond cant or tapered strip into field of roof. Fabricate from the following materials:
1. Aluminum: 0.032 inch (0.81 mm) thick.

C. Conductor Heads: Fabricate conductor heads with flanged back and stiffened top edge and of dimensions and shape required, complete with outlet tubes, exterior flange trim, and built-in overflows. Fabricate from the following materials:
1. Aluminum: 0.032 inch (0.81 mm) thick.

D. Splash Pans: Fabricate to dimensions and shape required and from the following materials:
1. Aluminum: 0.040 inch (1.02 mm) thick.

2.6 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. Roof Edge Flashing (Gravel Stop) and Fascia Cap: Fabricate in minimum 96-inch- (2400-mm-) long, but not exceeding 12-foot- (3.6-m-) long sections. Furnish with 6-inch- (150-mm-) wide, joint cover plates. Shop fabricate interior and exterior corners.
1. Joint Style: Overlapped, 4 inches (100 mm) wide.
2. Fabricate with scuppers spaced 10 feet (3 m) apart, to dimensions required with 4-inch- (100-mm-) wide flanges and base extending 4 inches (100 mm) beyond cant or tapered strip into field of roof. Fasten gravel guard angles to base of scupper.
3. Fabricate from the following materials:

a. Aluminum: 0.050 inch (1.27 mm) thick.

B. Copings: Fabricate in minimum 96-inch- (2400-mm-) long, but not exceeding 12-foot- (3.6-m-) long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and drill elongated holes for fasteners on interior leg. Miter corners, fasten and seal watertight. Shop fabricate interior and exterior corners.
1. Coping Profile: Custom reveal profile at all brick walls. Reference drawings. Profile at metal panel walls in accordance with SMACNA's "Architectural Sheet Metal Manual." Reference drawings.
2. Joint Style: Butted with expansion space and 6-inch- (150-mm-) wide, concealed backup plate.
3. Fabricate from the following materials:
a. Aluminum: 0.050 inch (1.27 mm) thick.

C. Base Flashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:
1. Stainless Steel: 0.0188 inch (0.477 mm) thick.

D. Counterflashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:
1. Stainless Steel: 0.0188 inch (0.477 mm) thick.

E. Flashing Receivers: Fabricate from the following materials:
1. Stainless Steel: 0.0156 inch (0.396 mm) thick.

F. Roof-Penetration Flashing: Fabricate from the following materials:
1. Stainless Steel: 0.0188 inch (0.477 mm) thick.

G. Roof-Drain Flashing: Fabricate from the following materials:
1. Stainless Steel: 0.0156 inch (0.396 mm) thick.

2.7 WALL SHEET METAL FABRICATIONS

A. Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch- (2400-mm-) long, but not exceeding 12-foot- (3.6-m-) long, sections, under copings, and at shelf angles. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches (150 mm) beyond each side of wall openings; and form with 2-inch- (50-mm-) high, end dams. Fabricate from the following materials:
1. Stainless Steel: 0.0156 inch (0.396 mm) thick.

B. Opening Flashings in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend 4 inches (100 mm) beyond wall openings. Form head and sill flashing with 2-inch- (50-mm-) high, end dams. Fabricate from the following materials:
1. Stainless Steel: 0.0156 inch (0.396 mm) thick.

2.8 MISCELLANEOUS SHEET METAL FABRICATIONS

A. Equipment Support Flashing: Fabricate from the following materials:
   1. Stainless Steel: 0.0188 inch (0.477 mm) thick.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.
   1. Verify compliance with requirements for installation tolerances of substrates.
   2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
   3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.
   1. Install fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
   2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder,welds and sealant.
   3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
   4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
   5. Install continuous cleats with fasteners spaced not more than 12 inches (300 mm) o.c.
   6. Space individual cleats not more than 12 inches (300 mm) apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
   7. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.
   8. Do not field cut sheet metal flashing and trim by torch.
   9. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
   1. Coat concealed side of uncoated-aluminum and stainless steel sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
   2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.
   1. Space movement joints at maximum of 10 feet (3 m) with no joints within 24 inches (600 mm) of corner or intersection.
   2. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with sealant concealed within joints.
   3. Use lapped expansion joints only where indicated on Drawings.

D. Fasteners: Use fastener sizes that penetrate [substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance].

E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

F. Seal joints as required for watertight construction.
   1. Use sealant-filled joints unless otherwise indicated.
      a. Embed hooked flanges of joint members not less than 1 inch (25 mm) into sealant.
      b. Form joints to completely conceal sealant.
      c. When ambient temperature at time of installation is between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way.
      d. Adjust setting proportionately for installation at higher ambient temperatures.
         1) Do not install sealant-type joints at temperatures below 40 deg F (4 deg C).
   2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter.
   1. Pre-tin edges of sheets with solder to width of 1-1/2 inches (38 mm); however, reduce pre-tinning where pre-tinned surface would show in completed Work.
   2. Do not solder metallic-coated steel and aluminum sheet.
   3. Do not use torches for soldering.
   4. Heat surfaces to receive solder, and flow solder into joint.
      a. Fill joint completely.
      b. Completely remove flux and spatter from exposed surfaces.
   5. Stainless Steel Soldering:
      a. Tin edges of uncoated sheets, using solder for stainless steel and acid flux.
      b. Promptly remove acid-flux residue from metal after tinning and soldering.
      c. Comply with solder manufacturer's recommended methods for cleaning and neutralization.

H. Rivets: Rivet joints in uncoated aluminum where necessary for strength.

3.3 INSTALLATION OF ROOF-DRAINAGE SYSTEM

A. Install sheet metal roof-drainage items to produce complete roof-drainage system in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.

B. Downspouts:
1. Join sections with 1-1/2-inch (38-mm) telescoping joints.
2. Provide hangers with fasteners designed to hold downspouts securely to walls.
3. Locate hangers at top and bottom and at approximately 60 inches (1500 mm) o.c.
4. Provide elbows at base of downspout to direct water away from building (roof only).
5. Connect downspouts to underground drainage system.

C. Splash Pans:
1. Install where downspouts discharge on low-slope roofs.
2. Set in elastomeric sealant compatible with the substrate.

D. Parapet Scuppers:
1. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
2. Solder or seal with elastomeric sealant exterior wall scupper flanges into back of conductor head.

E. Conductor Heads: Anchor securely to wall, with elevation of conductor head rim at minimum of 1 inch (25 mm) below scupper discharge.

3.4 INSTALLATION OF ROOF FLASHINGS

A. Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and cited sheet metal standard.
1. Provide concealed fasteners where possible, and set units true to line, levels, and slopes.
2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

B. Roof Edge Flashing:
1. Install roof edge flashings in accordance with ANSI/SPRI/FM 4435/ES-1.
2. Anchor to resist uplift and outward forces in accordance with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for FM Approvals' listing for required windstorm classification.

C. Copings:
1. Install roof edge flashings in accordance with ANSI/SPRI/FM 4435/ES-1.
2. Anchor to resist uplift and outward forces in accordance with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for specified FM Approvals' listing for required windstorm classification.

D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches (100 mm) over base flashing. Install stainless steel draw band and tighten.

E. Counterflashing: Coordinate installation of counterflashing with installation of base flashing.
   1. Insert counterflashing in reglets or receivers and fit tightly to base flashing.
   2. Extend counterflashing 4 inches (100 mm) over base flashing.
   3. Lap counterflashing joints minimum of 4 inches (100 mm).
   4. Secure in waterproof manner by means of snap-in installation and sealant or lead wedges and sealant or interlocking folded seam or blind rivets and sealant unless otherwise indicated.

F. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

3.5 INSTALLATION OF WALL FLASHINGS

A. Install sheet metal wall flashing to intercept and exclude penetrating moisture in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

B. Opening Flashings in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches (100 mm) beyond wall openings.

C. Reglets: Installation of reglets is specified in Section 042000 "Unit Masonry."

3.6 INSTALLATION OF MISCELLANEOUS FLASHING

A. Equipment Support Flashing:
   1. Coordinate installation of equipment support flashing with installation of roofing and equipment.
   2. Weld or seal flashing with elastomeric sealant to equipment support member.

3.7 INSTALLATION TOLERANCES

A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines indicated on Drawings and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.8 CLEANING

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder.

C. Clean off excess sealants.

3.9 PROTECTION

A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

B. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended in writing by sheet metal flashing and trim manufacturer.

C. Maintain sheet metal flashing and trim in clean condition during construction.

D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

END OF SECTION 076200

SECTION 076220 - GUTTERS AND DOWNSPOUTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes shop and field formed metal roofing accessories and trim, such as:
   1. Built-in Gutters.
   2. Hung gutters.
   3. Downspouts (rain drainage).
   4. Miscellaneous accessories such as downspout strainers and gutter covers.

B. Related Requirements:
   1. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to work of this Section.
   2. Section 076210 - Copper Roofing Specialties: Roof accessory units of pre-manufactured, set-on type.

1.2 COORDINATION

A. Coordinate work of this section with interfacing and adjacent work for proper sequencing. Ensure weather resistance and durability of work and protection of materials and finishes.

1.3 PREINSTALLATION MEETINGS

A. At project site.

1.4 PERFORMANCE REQUIREMENTS

A. Installation Requirements: Fabricator is responsible for installing system, including anchorage to substrate and necessary modifications to meet specified and drawn requirements and maintain visual design concepts in accordance with Contract Documents and following installation methods as stipulated in the "SMCNA" handbook published by the Copper Development Association (CDA).
   1. Drawings are diagrammatic and are intended to establish basic dimension of units, sight lines, and profiles of units.
   2. Make modifications only to meet field conditions and to ensure fitting of system components.
   3. Obtain Architect's approval of modifications.
   4. Provide concealed fastening wherever possible.
   5. Attachment considerations: Account for site peculiarities and expansion and contraction movements so there is no possibility of loosening, weakening and fracturing connection between units and building structure or between components themselves.
   6. Obtain Architect's approval for connections to building elements at locations other than

indicated in Drawings.

7. Accommodate building structure deflections in system connections to structure.

B. Performance Requirements:
   1. System shall accommodate movement of components without buckling, failure of joint seals, undue stress on fasteners, or other detrimental effects when subjected to seasonal temperature changes and live loads.
   2. Design system capable of withstanding building code requirements for negative wind pressure.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each product and accessory.

C. Shop drawings showing:

D. Plans, elevations, sections, profiles, expansion provisions, gutter slopes, methods of joining, and anchorage details, including downspout strainers, gutter covers, scuppers, and conductor head, and attachments to built-in plumbing drain lines, scuppers, and conductor head systems.

E. Distinguish between shop - and field-assembled work.

F. Include identification of material, thickness, weight, and finish for each item and location in Project. Provide layouts at 1/4 inch (1:50) scale and details at 3 inch (1:4) scale.

G. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.

H. Include details of termination points and assemblies.

I. Include details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.

J. Include details of roof-penetration flashing.

K. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counterflashings as applicable.

L. Include details of connections to adjoining work.

M. Detail formed flashing and trim at scale of not less than 1-1/2 inches per 12 inches.

N. Samples for Initial Selection: For each type of sheet metal and accessory indicated with factory-applied finishes.

O. Samples for Verification: For each type of exposed finish.

P. Trim, Metal Closures, Expansion Joints, Joint Intersections, and Miscellaneous Fabrications: 12 inches long and in required profile. Include fasteners and other exposed accessories.

Q. Unit-Type Accessories and Miscellaneous Materials: Full-size Sample.

R. Anodized Aluminum Samples: Samples to show full range to be expected for each color required.

S. Samples of the following flashing, sheet metal, and accessory items:
   1. 6-inch (150 mm) or 12-inch (300 mm) square samples of specified sheet materials to be exposed as finished surfaces.
   2. 6-inch (150 mm) or 12-inch (300 mm) long samples of fabricated products exposed as finished work. Provide complete with specified finish.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

B. Product Certificates: For each type of coping and roof edge flashing that is SPRI ES-1 tested and FM Approvals approved.

C. Product Test Reports: For each product, for tests performed by a qualified testing agency.

D. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Provide maintenance data in Operations and Maintenance manual for maintaining applied coatings on copper panels.

1.8 QUALITY ASSURANCE

A. Fabricator’s Qualifications: Company specializing in copper gutter and downspout work with three years experience in similar size and type of installations.

B. Installer: A firm with 3 years of successful experience with installation of gutter and downspout work of type and scope equivalent to Work of this Section.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling, and Unloading: Protect finish metal faces.

B. Acceptance at Site: Examine each component and accessory as delivered and confirm that material and finish is undamaged. Do not accept or install damaged materials.

C. Storage and Protection:
1. Stack pre-formed material to prevent twisting, bending, and abrasions.
2. Provide ventilation.
3. Prevent contact with materials which may cause discoloration or staining.
4. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
5. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.10 WARRANTY

A. Warrant installed gutters, downspouts, and trim components to be free from defects in material and workmanship for period of 2 years.

B. Include coverage against leakage and damages to finishes.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Roof Specialties shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. SPRI Wind Design Standard: Manufacture and install copings and roof edge flashings tested according to SPRI ES-1 and capable of resisting the following design pressure:

D. Design Pressure: As indicated on Drawings.

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

F. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 ROOF-DRAINAGE SHEET METAL FABRICATIONS

A. Hanging Gutters: Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required. Fabricate in minimum 96-inch- long sections. Furnish flat-

stock gutter brackets and flat-stock gutter spacers and straps fabricated from same metal as gutters, of size recommended by cited sheet metal standard but with thickness not less than twice the gutter thickness. Fabricate expansion joints, expansion-joint covers, gutter bead reinforcing bars, and gutter accessories from same metal as gutters. Shop fabricate interior and exterior corners.

B. Gutter Profile: Style A according to cited sheet metal standard.

C. Expansion Joints: Butt type with cover plate.

D. Gutters with Girth 16 to 20 Inches: Fabricate from the following materials:

E. Aluminum: 0.040 inch thick.

F. Gutters with Girth 21 to 25 Inches: Fabricate from the following materials:

G. Aluminum: 0.050 inch thick.

H. Downspouts: Fabricate rectangular downspouts to dimensions indicated, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors.

I. Fabricate from the following materials:

J. Aluminum: 0.024 inch thick.

K. Finish: Two-coat fluoropolymer.

L. Color: As selected by Architect from manufacturer’s full range.

2.3 ACCESSORIES

A. Solder: ASTM B32; Provide 50-50 tin/lead or lead free alternative of similar or greater strength solder. Killed acid flux.

B. Fasteners: Same metal as flashing/sheet metal or other non-corrosive metal as recommended by sheet manufacturer. Match finish of exposed heads with material being fastened.

C. Joint Sealant: Refer to Division 07.

D. Metal Accessories: Provide cleats, straps, hangers, anchoring devices, and similar accessory units as required for installation of work, noncorrosive, size and gage required for performance.

PART 3 EXECUTION

3.1 EXAMINATION

A. General: Examine conditions and proceed with work when substrates are ready.

B. Confirm that substrate system is even, smooth, sound, clean, dry, and free from defects.

3.2 INSTALLATION

A. General: Anchor units of work securely in place by methods indicated, providing for thermal expansion of units; conceal fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weatherproof.

B. Install units plumb, level, square, and free from warp or twist while maintaining dimensional tolerances and alignment with surrounding construction; except install gutters with required slope.

C. Space cleats no more than 12 inches apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.

D. Fit gutters to downspouts and flashings for watertight connections. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.

E. Coordinate with installation of existing roofing system and roof accessories.

F. Flash and seal gutter to downspout.

G. Slope gutters not less than 1/8 inch per foot (1:100).

H. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.

I. Coat concealed side of uncoated-aluminum and stainless-steel sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.

J. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.

K. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.

L. Use lapped expansion joints only where indicated on Drawings.

M. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

N. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

O. Seal joints as required for watertight construction.

P. Use sealant-filled joints unless otherwise indicated. Embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F.

Q. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants.

R. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets with solder to width of 1-1/2 inches; however, reduce pre-tinning where pre-tinned surface would show in completed Work.

S. Do not solder aluminum sheet.

T. Do not use torches for soldering.

U. Heat surfaces to receive solder, and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

V. Stainless-Steel Soldering: Tin edges of uncoated sheets, using solder for stainless steel and acid flux. Promptly remove acid flux residue from metal after tinning and soldering. Comply with solder manufacturer's recommended methods for cleaning and neutralization.

W. Rivets: Rivet joints in uncoated aluminum where necessary for strength.

X. Downspouts: Join sections with 1-1/2-inch telescoping joints.

Y. Provide hangers with fasteners designed to hold downspouts securely to walls. Locate hangers at top and bottom and at approximately 60 inches o.c.

Z. Connect downspouts to existing underground drainage system.

AA. Splash Pans: Install where new downspouts are added and do not connect to existing underground drainage system.

3.3 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder.

C. Clean off excess sealants.

D. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended by sheet metal flashing and trim manufacturer. Maintain sheet metal flashing and trim in clean condition during construction.

E. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 076220

SECTION 077123 - MANUFACTURED GUTTERS AND DOWNSPOUTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Stainless steel gutter.

B. PVC Downspouts.

C. Leaf Guard.

D. Metal Gutter Expansion Joint.

E. Rivet and Solder Fastening.

1.2 RELATED REQUIREMENTS

A. Section 076100 - Sheet Metal Roofing.

B. Section 076200 - Sheet Metal Flashing and Trim.

C. Section 099113 - Exterior Painting: Field painting of metal surfaces.

1.3 REFERENCE STANDARDS

A. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; 2020.

B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.

C. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2023.

D. ASTM B32 - Standard Specification for Solder Metal; 2020.

E. ASTM D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings; 2020.

F. SMACNA (ASMM) - Architectural Sheet Metal Manual; 2012.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Comply with SMACNA (ASMM) for sizing components for rainfall intensity determined by a storm occurrence of 1 in 5 years.

B. Comply with applicable code for size and method of rain water discharge.

1.5 SUBMITTALS

A. Product Data: Provide data on prefabricated components.

B. Shop Drawings: Indicate locations, configurations, jointing methods, fastening methods, locations, and installation details.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Stack material to prevent twisting, bending, or abrasion, and to provide ventilation. Slope to drain.

B. Prevent contact with materials that could cause discoloration, staining, or damage.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Gutters and Leafguard:
1. ATAS International, Inc; Water Control System: www.atas.com/#sle.
2. Cheney Flashing Company: www.cheneyflashing.com/#sle.
3. Drexel Metals Inc: www.drexmet.com/#sle.
4. Walcoom: www.walcoom.com.
5. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 MATERIALS

A. Downspouts: Polyvinyl Chloride (PVC): ASTM D2665, virgin vinyl, SDR 35 pipe and fittings, high impact type, colorfast; color as selected.

B. Gutters: Galvanized Steel Sheet: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 0.02 inch thick base metal, colorfast to match downspout.

C. Stainless Steel: Welded ASTM A666 Type 304, soft temper, 0.015 inch thick; smooth No. 4 finish.

D. Solder: ASTM B32; Sn50 (50/50) type.

2.3 COMPONENTS

A. Gutters: SMACNA rectangular style profile.

B. Downspouts: Polyvinyl chloride (PVC); round profile.

C. Leaf Guard: Perforated rectangular plate to cover gutter; removable.

D. Anchors and Supports: Profiled to suit gutters and downspouts.
   1. Anchoring Devices: In accordance with CDA requirements.
   2. Gutter Supports: Brackets.
   3. Downspout Supports: Brackets.

E. Fasteners: Galvanized steel, with soft neoprene washers.

2.4 FABRICATION

A. Form gutters and downspouts of profiles and size indicated.

B. Fabricate with required connection pieces.

C. Form sections square, true, and accurate in size, in maximum possible lengths, free of distortion or defects detrimental to appearance or performance. Allow for expansion at joints.

D. Hem exposed edges of metal.

E. Fabricate gutter and downspout accessories; seal watertight.

2.5 FINISHES

A. Class I Clear Anodized Finish: AAMA 611 AA-M12C22A41, clear anodic coating not less than 0.7 mil, 0.0007 inch thick.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that surfaces are ready to receive work.

3.2 PREPARATION

A. Paint concealed sheet metal surfaces and surfaces in contact with dissimilar metals with protective backing paint to a minimum dry film thickness of 15 mil, 0.015 inch.

3.3 INSTALLATION

A. Install gutters, downspouts, and accessories in accordance with manufacturer's instructions.

B. Slope gutters 1 inch per foot .

END OF SECTION 077123

SECTION 077200 - ROOF ACCESSORIES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Work Results:

B. Principal Products:

C. Section Includes:
1. Roof curbs.
2. Equipment supports.

D. Related Requirements:
1. Section 055000 "Metal Fabrications" for metal vertical ladders, ships' ladders, and stairs for access to roof hatches.

1.3 COORDINATION

A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.

B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of roof accessory.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For roof accessories.
1. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.

C. Samples: For each exposed product and for each color and texture specified, prepared on

Samples of size to adequately show color.

D. Delegated-Design Submittal: For roof curbs and equipment supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Detail mounting, securing, and flashing of roof-mounted items to roof structure. Indicate coordinating requirements with roof membrane system.
   2. Wind-Restraint Details: Detail fabrication and attachment of wind restraints. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:
   1. Size and location of roof accessories specified in this Section.
   2. Method of attaching roof accessories to roof or building structure.
   3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
   4. Required clearances.

B. Sample Warranties: For manufacturer's special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

1.7 WARRANTY

A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
   2. Finish Warranty Period: 20 years from date of Final Acceptance.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design roof curbs and equipment supports to comply with wind performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Wind-Restraint Performance: As indicated on Drawings.

2.2 ROOF CURBS

A. Roof Curbs: Internally reinforced roof-curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings, bearing continuously on roof structure, and capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, stepped integral metal cant raised the thickness of roof insulation, and integrally formed deck-mounting flange at perimeter bottom.

B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.

C. Supported Load Capacity: Coordinate load capacity with information on Shop Drawings of equipment to be supported.

D. Material: Zinc-coated (galvanized) steel sheet, 0.079 inch (2.01 mm) thick.
   1. Finish: Baked enamel or powder coat.
   2. Color: As selected by Architect from manufacturer's full range.

E. Construction:
   1. Curb Profile: Manufacturer's standard compatible with roofing system.
   2. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
   3. Fabricate curbs to minimum height of 12 inches (305 mm) above roofing surface unless otherwise indicated.
   4. Top Surface: Level top of curb, with roof slope accommodated by sloping deck-mounting flange or by use of leveler frame.
   5. Insulation: Factory insulated with 1-1/2-inch- (38-mm-) thick glass-fiber board insulation.
   6. Liner: Same material as curb, of manufacturer's standard thickness and finish.
   7. Nailer: Factory-installed wood nailer along top flange of curb, continuous around curb perimeter.
   8. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb, of size and spacing required to meet wind uplift requirements.
   9. Platform Cap: Where portion of roof curb is not covered by equipment, provide weathertight platform cap formed from 3/4-inch- (19-mm-) thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
   10. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as curb.

2.3 EQUIPMENT SUPPORTS

A. Equipment Supports: Rail-type metal equipment supports capable of supporting superimposed live and dead loads between structural supports, including equipment loads and other construction indicated on Drawings, spanning between structural supports; capable of meeting performance requirements; with welded corner joints, stepped integral metal cant raised the thickness of roof insulation, and integrally formed structure-mounting flange at bottom.

B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.

C. Supported Load Capacity: Coordinate load capacity with information on Shop Drawings of equipment to be supported.

D. Material: Zinc-coated (galvanized) steel sheet, 0.079 inch (2.01 mm) thick.
   1. Finish: Baked enamel or powder coat.
   2. Color: As selected by Architect from manufacturer's full range.

E. Construction:
   1. Curb Profile: Manufacturer's standard compatible with roofing system.
   2. Insulation: Factory insulated with 1-1/2-inch thick glass-fiber board insulation.
   3. Liner: Same material as equipment support, of manufacturer's standard thickness and finish.
   4. Nailer: Factory-installed continuous wood nailers 5-1/2 inches wide on top flange of equipment supports, continuous around support perimeter.
   5. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb of size and spacing required to meet wind uplift requirements.
   6. Platform Cap: Where portion of equipment support is not covered by equipment, provide weathertight platform cap formed from 3/4-inch thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
   7. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as equipment support.
   8. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
   9. Fabricate equipment supports to minimum height of 12 inches above roofing surface unless otherwise indicated.

2.4 METAL MATERIALS

A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, G90 (Z275) coating designation.
   1. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil (0.005 mm).
   2. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils (0.05 mm).

B. Galvanized-Steel Tube: ASTM A500/A500M, round tube, hot-dip galvanized according to

ASTM A123/A123M.

2.5 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Polyisocyanurate Board Insulation: ASTM C1289, thickness and thermal resistivity as indicated.

C. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches (38 mm) thick.

D. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.

E. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.

F. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.

2.6 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

C. Verify dimensions of roof openings for roof accessories.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install roof accessories according to manufacturer's written instructions.
   1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
   2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
   3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
   4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
   1. Coat concealed side of stainless steel roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
   2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.
   3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.

C. Roof Curb Installation: Install each roof curb so top surface is level.

D. Equipment Support Installation: Install equipment supports so top surfaces are level with each other.

E. Seal joints with elastomeric or butyl sealant as required by roof accessory manufacturer.

3.3 REPAIR AND CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A780/A780M.

B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 099113 "Exterior Painting."

C. Clean exposed surfaces according to manufacturer's written instructions.

D. Clean off excess sealants.

E. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077200

SECTION 078100 - APPLIED FIREPROOFING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes sprayed fire-resistive materials.

1.3 DEFINITIONS

A. SFRM: Sprayed fire-resistive materials.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct a conference at the Project site.
   1. Review products, design ratings, restrained and unrestrained conditions, densities, thicknesses, bond strengths, and other performance requirements.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product, include the UL design designation indicating the location of the applicable assembly throughout the building.

B. Shop Drawings: Framing plans or schedules, or both, indicating the following:
   1. Extent of fireproofing for each construction and fire-resistance rating.
   2. Applicable fire-resistance design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction.
   3. Minimum fireproofing thicknesses needed to achieve the required fire-resistance rating of each structural component and assembly.
   4. Treatment of fireproofing after application. Specify treatment in areas to be left exposed for sealing and finish coating/painting to maintain durability.

C. Samples: For each exposed product and for each color and texture specified, in manufacturer's standard dimensions in size.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of fireproofing.

C. Evaluation Reports: For fireproofing, from ICC-ES.

D. Preconstruction Test Reports: For fireproofing.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by fireproofing manufacturer as experienced and with sufficient trained staff to install manufacturer's products according to specified requirements.

B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects.
   1. Build mockup of each type of fireproofing and different substrate and each required finish as shown on Drawings.
   2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Final Acceptance.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Owner will engage a qualified testing agency to perform preconstruction testing on field mockups of fireproofing.
   1. Field Mockup: one beam in exposed area t.
   2. Provide test specimens and assemblies representative of proposed materials and construction.

B. Preconstruction Adhesion and Compatibility Testing: Test for compliance with requirements for specified performance and test methods.
   1. Bond Strength: Test for cohesive and adhesive strength according to ASTM E 736. Provide bond strength indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
   2. Density: Test for density according to ASTM E 605. Provide density indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
   3. Verify that manufacturer, through its own laboratory testing or field experience, attests that primers or coatings are compatible with fireproofing.
   4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
   5. For materials failing tests, obtain applied-fireproofing manufacturer's written instructions for corrective measures including the use of specially formulated bonding agents or primers.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not apply fireproofing when ambient or substrate temperature is 44 deg F or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.

B. Ventilation: Ventilate building spaces during and after application of fireproofing, providing complete air exchanges according to manufacturer's written instructions. Use natural means or, if they are inadequate, forced-air circulation until fireproofing dries thoroughly.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Assemblies: Provide fireproofing, including auxiliary materials, according to requirements of each fire-resistance design and manufacturer's written instructions.

B. Source Limitations: Obtain fireproofing for each fire-resistance design from single source.

C. Fire-Resistance Design: Indicated on Drawings, tested according to ASTM E 119 or UL 263; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Steel members are to be considered unrestrained unless specifically noted otherwise.

D. Asbestos: Provide products containing no detectable asbestos.

2.2 SPRAYED FIRE-RESISTIVE MATERIALS

A. Sprayed Fire-Resistive Material: LOW DENSITY; Manufacturer's standard, factory-mixed, lightweight, dry formulation, complying with indicated fire-resistance design, and mixed with water at Project site to form a slurry or mortar before conveyance and application or conveyed in a dry state and mixed with atomized water at place of application.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Carboline Company; a subsidiary of RPM International.
      b. GCP Applied Technologies Inc.
      c. Isolatek International.
   2. Bond Strength: Minimum 150-lbf/sq. ft. cohesive and adhesive strength based on field testing according to ASTM E 736.
   3. Density: Not less than density specified in the approved fire-resistance design, according to ASTM E 605.
   4. Thickness: As required for fire-resistance design indicated, measured according to requirements of fire-resistance design or ASTM E 605, whichever is thicker, but not less than 0.375 inch.
   5. Combustion Characteristics: ASTM E 136.
   6. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: 0 or less.
b. Smoke-Developed Index: 0 or less.

7. Compressive Strength: Minimum 7 lbf/sq. in. according to ASTM E 761.
8. Corrosion Resistance: No evidence of corrosion according to ASTM E 937.
9. Deflection: No cracking, spalling, or delamination according to ASTM E 759.
10. Effect of Impact on Bonding: No cracking, spalling, or delamination according to ASTM E 760.
11. Air Erosion: Maximum weight loss of 0.25 g/sq. ft. in 24 hours according to ASTM E 859.
12. Fungal Resistance: Treat products with manufacturer's standard antimicrobial formulation to result in no growth on specimens per ASTM G 21 or rating of 10 according to ASTM D 3274 when tested according to ASTM D 3273.

B. Sprayed Fire-Resistive Material: Medium Density; Manufacturer's standard, factory-mixed, mediumweight, dry formulation, complying with indicated fire-resistance design, and mixed with water at Project site to form a slurry or mortar before conveyance and application or conveyed in a dry state and mixed with atomized water at place of application.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Carboline Company; a subsidiary of RPM International.
b. GCP Applied Technologies Inc.
c. Isolatek International.
2. Bond Strength: Minimum 430-lbf/sq. ft. cohesive and adhesive strength based on field testing according to ASTM E 736.
3. Density: Not less than density specified in the approved fire-resistance design, according to ASTM E 605.
4. Thickness: As required for fire-resistance design indicated, measured according to requirements of fire-resistance design or ASTM E 605, whichever is thicker, but not less than 0.375 inch.
5. Combustion Characteristics: ASTM E 136.
6. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
a. Flame-Spread Index: 0 or less.
b. Smoke-Developed Index: 0 or less.
7. Compressive Strength: Minimum 7,344 lbf/sq. in. according to ASTM E 761.
8. Corrosion Resistance: No evidence of corrosion according to ASTM E 937.
9. Deflection: No cracking, spalling, or delamination according to ASTM E 759.
10. Effect of Impact on Bonding: No cracking, spalling, or delamination according to ASTM E 760.
11. Air Erosion: Maximum weight loss of 0.25 g/sq. ft. in 24 hours according to ASTM E 859.
12. Fungal Resistance: Treat products with manufacturer's standard antimicrobial formulation to result in no growth on specimens per ASTM G 21 or rating of 10 according to ASTM D 3274 when tested according to ASTM D 3273.

2.3 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that are compatible with fireproofing and substrates and

are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of the Work and according to each fire-resistance design.
   1. Verify that substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, paints, and encapsulants, or other foreign substances capable of impairing bond of fireproofing with substrates under conditions of normal use or fire exposure.
   2. Verify that objects penetrating fireproofing, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.
   3. Verify that substrates receiving fireproofing are not obstructed by ducts, piping, equipment, or other suspended construction that will interfere with fireproofing application.

B. Verify that concrete work on steel deck is complete before beginning fireproofing work.

C. Verify that roof construction, installation of rooftop HVAC equipment, and other related work are complete before beginning fireproofing work.

D. Conduct tests according to fireproofing manufacturer's written instructions to verify that substrates are free of substances capable of interfering with bond.

E. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Cover other work subject to damage from fallout or overspray of fireproofing materials during application.

B. Clean substrates of substances that could impair bond of fireproofing.

C. Prime substrates where included in fire-resistance design and where recommended in writing by fireproofing manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive fireproofing.

D. For applications visible on completion of Project, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of fireproofing. Remove minor projections and fill voids that would telegraph through fire-resistive products after application.

3.3 APPLICATION

A. Construct fireproofing assemblies that are identical to fire-resistance design indicated and products as specified, tested, and substantiated by test reports; for thickness, primers, sealers, topcoats, finishing, and other materials and procedures affecting fireproofing work.

B. Comply with fireproofing manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and apply fireproofing; as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.

C. Coordinate application of fireproofing with other construction to minimize need to cut or remove fireproofing.
   1. Do not begin applying fireproofing until clips, hangers, supports, sleeves, and other items penetrating fireproofing are in place.
   2. Defer installing ducts, piping, and other items that would interfere with applying fireproofing until application of fireproofing is completed.

D. Metal Decks:
   1. Do not apply fireproofing to underside of metal deck substrates until concrete topping, if any, is completed.
   2. Do not apply fireproofing to underside of metal roof deck until roofing is completed; prohibit roof traffic during application and drying of fireproofing.

E. Install auxiliary materials as required, as detailed, and according to fire-resistance design and fireproofing manufacturer's written instructions for conditions of exposure and intended use. For auxiliary materials, use attachment and anchorage devices of type recommended in writing by fireproofing manufacturer.

F. Spray apply fireproofing to maximum extent possible. After the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by fireproofing manufacturer.

G. Extend fireproofing in full thickness over entire area of each substrate to be protected.

H. Install body of fireproofing in a single course unless otherwise recommended in writing by fireproofing manufacturer.

I. Provide a uniform finish complying with description indicated for each type of fireproofing material and matching finish approved for required mockups.

J. Cure fireproofing according to fireproofing manufacturer's written instructions.

K. Do not install enclosing or concealing construction until after fireproofing has been applied, inspected, and tested and corrections have been made to deficient applications.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
   1. Test and inspect as required by the IBC, Subsection 1705.13, "Sprayed Fire-Resistant Materials." as indicated on Schedule of Special Inspections.

B. Fireproofing will be considered defective if it does not pass tests and inspections.
   1. Remove and replace fireproofing that does not pass tests and inspections, and retest.
   2. Apply additional fireproofing, per manufacturer's written instructions, where test results indicate insufficient thickness, and retest.

3.5 CLEANING, PROTECTING, AND REPAIRING

A. Cleaning: Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.

B. Protect fireproofing, according to advice of manufacturer and Installer, from damage resulting from construction operations or other causes, so fireproofing is without damage or deterioration at time of Final Acceptance.

C. As installation of other construction proceeds, inspect fireproofing and repair damaged areas and fireproofing removed due to work of other trades.

D. Repair fireproofing damaged by other work before concealing it with other construction.

E. Repair fireproofing by reapplying it using same method as original installation or using manufacturer's recommended trowel-applied product.

END OF SECTION 078100

SECTION 078400 - FIRESTOPPING

PART 1 GENERAL

1.1 SUMMARY

A. Work Results:

B. Principal Products:

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Section, apply to work specified in this section.

1.3 DEFINITIONS

A. Firestopping: Material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gases through penetrations in, or construction joints between, fire rated wall and floor assemblies.

1.4 GENERAL DESCRIPTION OF THE WORK OF THIS SECTION

A. Only tested firestop systems shall be used in specific locations as follows:
   1. Penetrations for the passage of duct, cable, cable tray, conduit, piping, electrical busways and raceways through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions.
   2. Safing slot gaps between edge of floor slabs and curtain walls.
   3. Openings between structurally separate sections of wall or floors.
   4. Gaps between the top of walls and ceilings or roof assemblies.
   5. Expansion joints in walls and floors.
   6. Openings and penetrations in fire-rated partitions or walls containing fire doors.
   7. Openings around structural members which penetrate floors or walls.

1.5 RELATED WORK OF OTHER SECTIONS

A. Coordinate work of this section with work of other sections as required to properly execute the work and as necessary to maintain satisfactory progress of the work of other sections, including:
   1. Section 033000 - Cast-In-Place Concrete.
   2. Section 042000 - Unit Masonry.
   3. Section 079000 - Joint Sealants.

4. Section 210000 - Fire Suppression.
5. Section 220000 - Plumbing.
6. Section 230000 - Heating, Ventilating, and Air Conditioning (HVAC).
7. Section 260000 - Electrical.
8. Section 270000 - Communications.

1.6 REFERENCES

A. Test Requirements: ASTM E 814, "Standard Method of Fire Tests of Through Penetration Fire Stops."

B. Test Requirements: UL 1479, “Fire Tests of Through-Penetration Firestops”.

C. Test Requirements: UL 2079, “Tests for Fire Resistance of Building Joint Systems”.

D. Underwriters Laboratories (UL) of Northbrook, IL publishes tested systems in their "FIRE RESISTANCE DIRECTORY" that is updated annually.
   1. UL Fire Resistance Directory:
      a. Firestop Devices (XHJI).
      b. Fire Resistance Ratings (BXRH).
      c. Through-Penetration Firestop Systems (XHEZ).
      d. Fill, Voids, or Cavity Material (XHHW).
      e. Forming Materials (XHKU).
      f. Joint Systems (XHBN).
      g. Perimeter Fire Containment Systems (XHDG).
   2. Alternate Systems: “Omega Point Laboratories Directory” (updated annually).

E. Test Requirements: ASTM E 1966, “Standard Test Method for Fire Resistive Joint Systems”.

F. Test Requirements: ASTM E 2307, “Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate-Scale, Multi-story Test Apparatus”.

G. Inspection Requirements: ASTM E 2174, “Standard Practice for On-site Inspection of Installed Fire Stops”.

H. ASTM E 84, “Standard Test Method for Surface Burning Characteristics of Building Materials”.

I. ASTM D6904, “Standard Practice for Resistance to Wind Driven Rain for Exterior Coatings Applied on Masonry”.

J. ASTM C 679, “Standard Test Method for Tack-Free Time of Elastomeric Sealants”.

K. International Firestop Council Guidelines for Evaluating Firestop Systems Engineering Judgments.

L. North Carolina Building Code (NCBC 2012).

M. NFPA 101 - Life Safety Code.

N. NFPA 70 - National Electric Code.

1.7 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Provide through-penetration fire stop systems and fire-resistive joint systems that comply with specified requirements of tested systems.

B. Firestop System installation must meet requirements of ASTM E 814, UL 1479 or UL 2079 tested assemblies that provide a fire rating equal to that of construction being penetrated.

C. Proposed fire stop materials and methods shall conform to applicable governing codes having local jurisdiction.

D. Firestop Systems do not reestablish the structural integrity of load bearing partitions/assemblies, or support live loads and traffic. Installer shall consult the structural engineer prior to penetrating any load bearing assembly.

E. For those firestop applications that exist for which no qualified tested system is available through a manufacturer, an engineering judgment derived from similar qualified tested system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineering judgment documents must follow requirements set forth by the International Firestop Council.

1.8 SUBMITTALS

A. Submit Product Data: Manufacturer's specifications and technical data for each material including the composition and limitations, documentation of qualified tested firestop systems to be used and manufacturer's installation instructions to comply with Section 013000.

B. Manufacturer's engineering judgment identification number and document details when no qualified tested system is available for an application. Engineering judgment must include both project name and contractor’s name who will install firestop system as described in document.

C. Submit safety data sheets provided with product delivered to job-site.

1.9 INSTALLER QUALIFICATIONS

A. Engage an experienced Installer who is certified, licensed, or otherwise qualified by the firestopping manufacturer as having been provided the necessary training to install manufacturer’s products per specified requirements. A supplier’s willingness to sell its firestopping products to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.

B. Installation Responsibility: assign installation of through-penetration firestop systems and fire-resistive joint systems in Project to a single sole source firestop specialty contractor.

C. The work is to be installed by a contractor with at least one of the following qualifications:
   1. FM 4991 Approved Contractor.
   2. UL Approved Contractor.
   3. Manufacturers Certification such as Hilti Accredited Fire Stop Specialty Contractor.

D. The installer must have no less than 3 years of experience with fire stop installation in buildings of similar size, scope & magnitude.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials undamaged in manufacturer's clearly labeled, unopened containers, identified with brand, type, and UL label where applicable.

B. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at job-site.

C. Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements, including temperature restrictions.

D. Comply with recommended procedures, precautions or remedies described in material safety data sheets as applicable.

E. Do not use damaged or expired materials.

1.11 PROJECT CONDITIONS

A. Do not use materials that contain flammable solvents.

B. Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings.

C. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.

D. Weather conditions: Do not proceed with installation of firestop materials when temperatures exceed the manufacturer's recommended limitations for installation printed on product label and product data sheet.

E. During installation, provide masking and drop cloths to prevent firestopping materials from contaminating any adjacent surfaces.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under

conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.

B. Provide components for each firestopping system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

C. Provide a round fire-rated cable management device whenever cables penetrate fire rated walls, where frequent cable changes and additions may occur. The fire-rated cable management device shall consist of a corrugated steel tube with zinc coating, contain and inner plastic housing, intumescent material rings, and inner fabric smoke seal membrane. The length of the sleeve shall be 12.4 inches. The fire-rated cable management device shall contain integrated intumescent firestop wrap strip materials sufficient to maintain the hourly rating of the barrier being penetrated. The fire-rated cable management device shall contain a smoke seal fabric membrane or intumescent firestop plugs sufficient to achieve the L-Rating requirements of the barrier type. Install device per the manufacturer's published installation instructions.

D. Penetrations in Fire Resistance Rated Walls: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.
   1. F-Rating: Not less than the fire-resistance rating of the wall construction being penetrated.

E. Penetrations in Horizontal Assemblies: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.
   1. F-Rating: Minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.
   2. T-Rating: when penetrant is located outside of a wall cavity, minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.

F. Penetrations in Smoke Barriers: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.
   1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at both ambient and elevated temperatures.

G. Mold Resistance: Provide penetration firestopping with mold and mildew resistance rating of one (1) or less as tested per ASTM G21.

H. Rain and water resistance: provide perimeter joint sealant tested in accordance with ASTM D 6904 with less than 1 hour tack free time as tested in accordance with ASTM C 679.

I. Firestopping Materials are either "cast-in-place" (integral with concrete placement) or "post installed." Provide cast-in-place firestop devices prior to concrete placement.

2.2 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with through penetration firestop systems (XHEZ), joint systems (XHBN), and perimeter firestop systems (XHDG) listed in Volume 2 of the UL Fire Resistance Directory; provide Hilti, Inc.; or a comparable product by one of the following:
   1. 3M Fire Protection Products.
   2. A/D Fire Protection Systems Inc.
   3. RectorSeal.
   4. Rockwool International.
   5. Thermafiber, Inc.; an Owens Corning company.
   6. Tremco, Inc.

2.3 MATERIALS

A. Use only firestop products that have been UL 1479, ASTM E 814 or UL 2079 tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.

B. Pre-formed firestop devices for use with noncombustible and combustible pipes (closed and open systems), conduit, and/or cable bundles penetrating concrete floors the following products are acceptable:
   1. Hilti Cast-In Place Firestop Device (CP 680-P).
   2. Add Aerator Adaptor when used in conjunction with aerator system.
   3. Hilti Cast-In Place Firestop Device (CP 680-M) for use with noncombustible penetrants.
   4. Hilti Tub Box Kit (CP 681) for use with tub installations.
   5. Hilti Firestop Speed Sleeve (CP 653) for use with cable penetrations.
   6. Hilti Firestop Drop-In Device (CFS-DID) for use with noncombustible and combustible penetrants.
   7. Hilti Firestop Block (CFS-BL).
   8. Hilti Closet Stub (CFS-CID CS).

C. Sealants, caulking materials, or foams for use with non-combustible items including steel pipe, copper pipe, rigid steel conduit and electrical metallic tubing (EMT), the following products are acceptable:
   1. Hilti Intumescent Firestop Sealant (FS-ONE MAX).
   2. Hilti Fire Foam (CP 620).
   3. Hilti Flexible Firestop Sealant (CP 606).
   4. Hilti Firestop Silicone Sealant Gun Grade (CFS-S SIL GG).
   5. Hilti Firestop Silicone Sealant Self Leveling (CFS-S SIL SL).

D. Sealants or caulking materials for use with sheet metal ducts, the following products are acceptable:
   1. Hilti Silicone Sealant Gun Grade (CFS-S SIL GG).
   2. Hilti Firestop Silicone Sealant Self Leveling (CFS-S SIL SL).
   3. Hilti Flexible Firestop Sealant (CP 606).
   4. Hilti Intumescent Firestop Sealant (FS-ONE MAX).

E. Sealants, sprays, or pre-formed materials for use with fire-rated construction joints and other gaps, the following products are acceptable:
   1. Hilti Firestop Top Track Seal (CFS-TTS).
   2. Hilti Firestop Joint Spray (CFS-SP WB).
   3. Hilti Firestop Silicone Joint Spray (CFS-SP SIL).
   4. Hilti Flexible Firestop Sealant (CP 606).
   5. Hilti Firestop Silicone Sealant Gun Grade (CFS-S SIL GG).
   6. Hilti Firestop Silicone Sealant Self Leveling (CFS-S SIL SL).
   7. Hilti Bottom-of-Wall Sealant (CP 605).

F. Pre-formed mineral wool designed to fit flutes of metal profile deck and gap between top of wall and metal profile deck; as a backer for spray material.
   1. Hilti Speed Plugs (CP 777).
   2. Hilti Speed Strips (CP 767).

G. Intumescent sealants, caulking materials for use with combustible items (penetrants consumed by high heat and flame) including insulated metal pipe, PVC jacketed, flexible cable or cable bundles and plastic pipe, the following products are acceptable:
   1. Hilti Intumescent Firestop Sealant (FS-ONE MAX).

H. Foams, intumescent sealants, or caulking materials for use with flexible cable or cable bundles, the following products are acceptable:
   1. Hilti Intumescent Firestop Sealant (FS-ONE MAX).
   2. Hilti Fire Foam (CP 620).
   3. Hilti Flexible Firestop Sealant (CP 606).
   4. Hilti Firestop Silicone Sealant Gun Grade (CFS-S SIL GG).
   5. Hilti Firestop Silicone Sealant Self Leveling (CFS-S SIL SL).

I. Non-curing, re-penetrable intumescent putty or foam materials for use with flexible cable or cable bundles, the following products are acceptable:
   1. Hilti Firestop Putty Stick (CP 618).
   2. Hilti Firestop Plug (CFS-PL).

J. Wall opening protective materials for use with U.L. listed metallic and specified nonmetallic outlet boxes, the following products are acceptable:
   1. Hilti Firestop Putty Pad (CFS-P PA).
   2. Hilti Firestop Putty Pad (CP 617).
   3. Hilti Firestop Box Insert.

K. Firestop collar or wrap devices attached to assembly around combustible plastic pipe (closed and open piping systems), the following products are acceptable:
   1. Hilti Firestop Collar (CP 643N).
   2. Hilti Firestop Collar (CP 644).
   3. Hilti Wrap Strips (CP 648-E/648-S).

L. Materials used for large openings and complex penetrations made to accommodate cable trays and bundles, multiple steel and copper pipes, electrical busways in raceways, the following products are acceptable:
   1. Hilti Firestop Block (CFS-BL).

2. Hilti Composite Sheet (CFS-COS).
3. Hilti Firestop Mortar (CP 637).
4. Hilti Fire Foam (CP 620).
5. Hilti Firestop Board (CP 675T).

M. Non-curing, re-penetrable materials used for large size/complex penetrations made to accommodate cable trays and bundles, multiple steel and copper pipes, electrical busways in raceways, the following products are acceptable:
1. Hilti Firestop Block (CFS-BL).
2. Hilti Firestop Board (CP 675T).

N. Re-penetrable, round cable management devices for use with new or existing cable bundles penetrating gypsum or masonry walls, the following products are acceptable:
1. Hilti Firestop Speed Sleeve (CP 653) with integrated smoke seal fabric membrane.
2. Hilti Firestop Cable Collar (CFS-CC).
3. Hilti Firestop Sleeve (CFS-SL SK).
4. Hilti Retrofit Sleeve (CFS-SL RK) for use with existing cable bundles.
5. Hilti Gangplate (CFS-SL GP) for use with multiple cable management devices.
6. Hilti Gangplate Cap (CFS-SL GP CAP) for use at blank openings in gangplate for future penetrations.

O. Sealants or caulking materials used for openings between structurally separate sections of wall and floors, the following products are acceptable:
1. Hilti Firestop Joint Spray (CFS-SP WB).
2. Hilti Flexible Firestop Sealant (CP 606).
3. Hilti Firestop Silicone Sealant Gun Grade (CFS-S SIL GG).
4. Hilti Firestop Silicone Sealant Self Leveling (CFS-S SIL SL).

P. For blank openings made in fire-rated wall or floor assemblies, where future penetration of pipes, conduits, or cables is expected, the following products are acceptable:
1. Hilti Firestop Block (CFS-BL).
2. Hilti Firestop Plug (CFS-PL).

Q. For single or cable bundles up to one inch diameter penetrating gypsum, masonry, concrete walls or wood floor assemblies the following product is acceptable:
1. Hilti Firestop Cable Disc (CFS-D).

PART 3 EXECUTION

3.1 PREPARATION

A. Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.
1. Verify penetrations are properly sized and in suitable condition for application of materials.
2. Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, rust, laitance, release agents, water repellents, and any other substances that may affect proper adhesion.
3. Provide masking and temporary covering to prevent soiling of adjacent surfaces by

firestopping materials.

4. Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.
5. Do not proceed until unsatisfactory conditions have been corrected.

3.2 COORDINATION

A. Coordinate construction of openings, penetrations and construction joints to ensure that the fire stop systems are installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration fire stop systems. Coordinate construction and sizing of joints to ensure that fire-resistive joint systems are installed according to specified requirements.

C. Coordinate fire stopping with other trades so that obstructions are not placed in the way prior to the installation of the fire stop systems.

D. Do not cover up through-penetration fire stop and joint system installations that will become concealed behind other construction until each installation has been examined by the building inspector.

3.3 INSTALLATION

A. Regulatory Requirements: Install firestop materials in accordance with UL Fire Resistance Directory or Omega Point Laboratories Directory.

B. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of through-penetration and construction joint materials.
   1. Seal all holes or voids made by penetrations to ensure an air and water resistant seal.
   2. Consult with mechanical engineer, project manager, and damper manufacturer prior to installation of UL firestop systems that might hamper the performance of fire dampers as it pertains to duct work.
   3. Protect materials from damage on surfaces subjected to traffic.

3.4 FIELD QUALITY CONTROL

A. Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas.

B. Keep areas of work accessible until inspection by applicable code authorities.

C. Inspection of through-penetration firestopping shall be performed in accordance with ASTM E 2174, “Standard Practice for On-Site Inspection of Installed Fire Stops” or other recognized standard.

D. Perform under this section patching and repairing of firestopping caused by cutting or penetrating of existing firestop systems already installed by other trades.

E. Manufacturer’s Field Services: Contractor to ensure a manufacturer’s direct representative is on-site during initial installation of firestop systems to train appropriate contractor personnel in proper selection and installation procedures. Training will be done per manufacturer’s written recommendations published in their literature and drawing details. During installation, contractor shall have manufacturer’s representative provide periodic visual observations and written documentation of the results. Contact Hilti for support at 800.879.8000.

3.5 IDENTIFICATION & DOCUMENTATION

A. The firestop contractor is to supply documentation for each single application addressed. This documentation is to identify each penetration and joint location on the entire project.
   1. The Documentation Form for through penetrations is to include:
      a. A Sequential Location Number.
      b. The Project Name.
      c. Date of Installation.
      d. Detailed Description of the Penetration’s Location.
      e. Tested System or Engineered Judgment Number.
      f. Type of Assembly Penetrated.
      g. A Detailed Description of the Size and Type of Penetrating Item.
      h. Size of Opening.
      i. Number of Sides of Assemblies Addressed.
      j. Hourly Rating to be Achieved.
      k. Installer’s Name.
   2. The Documentation Form for Construction Joints is to include:
      a. A Sequential Location Number.
      b. The Project Name.
      c. Date of Installation.
      d. Detailed Description of the Construction Joint’s Location.
      e. Tested System or Engineered Judgment Number.
      f. Type of Construction Joint.
      g. The Width of the Joint.
      h. The Lineal Footage of the Joint.
      i. Number of Sides Addressed.
      j. Hourly Rating to be Achieved.
      k. Installer’s Name.

B. Copies of these documents are to be provided to the general contractor at the completion of the project.

C. Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on labels:
   1. The words: "Warning: Through Penetration Firestop System - Do Not Disturb. Notify Building Mngmnt of Any Damage."
   2. Contractor's name, address and phone number.
   3. Through-penetration firestop system designation of applicable testing and inspecting agency.

4. Date of installation.
5. Through-penetration firestop system manufacturer's name.
6. Installer's name.

D. Permanently attach identification labels to surfaces adjacent to and within 6 inches of firestopping edge so labels will be visible to anyone seeking to remove or change penetrating items or firestopping. Labels shall have a unique QR code for each penetration which can be scanned by the firestop documentation software to quickly identify the penetration attributes.

3.6 ADJUSTING AND CLEANING

A. Remove equipment, materials and debris, leaving area in undamaged, clean condition.

B. Clean all surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.

3.7 FIRESTOPPING SCHEDULE

A. Please see SCHEDULE OF COMMON FIRESTOP SYSTEMS 078400.01.

END OF SECTION 078400

SECTION 079200 - JOINT SEALANTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Silicone joint sealants.
   2. Latex joint sealants.
   3. Liquid joint sealants.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product.

B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch-wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Joint-Sealant Schedule: Include the following information:
   1. Joint-sealant application, joint location, and designation.
   2. Joint-sealant manufacturer and product name.
   3. Joint-sealant formulation.
   4. Joint-sealant color.

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each kind of joint sealant, for tests performed by a qualified testing agency.

B. Preconstruction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.

C. Field-Adhesion-Test Reports: For each sealant application tested.

D. Sample Warranties: For special warranties.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Product Testing: Test joint sealants using a qualified testing agency.
   1. Testing Agency Qualifications: Qualified according to ASTM C 1021 to conduct the testing indicated.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Laboratory Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
   1. Adhesion Testing: Use ASTM C 794 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
   2. Compatibility Testing: Use ASTM C 1087 to determine sealant compatibility when in contact with glazing and gasket materials.
   3. Stain Testing: Use ASTM C 1248 to determine stain potential of sealant when in contact with masonry substrates.
   4. Submit manufacturer's recommended number of pieces of each type of material, including joint substrates, joint-sealant backings, and miscellaneous materials.
   5. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
   6. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures, including use of specially formulated primers.
   7. Testing will not be required if joint-sealant manufacturers submit data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, staining of, and compatibility with joint substrates and other materials matching those submitted.

B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:
   1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
   2. Conduct field tests for each kind of sealant and joint substrate.
   3. Notify Architect seven days in advance of dates and times when test joints will be erected.
   4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
      a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1.1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.

1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.8 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:
   1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
   2. When joint substrates are wet.
   3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
   4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.9 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Two years from date of Final Acceptance.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Five years from date of Final Acceptance.

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
   1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
   2. Disintegration of joint substrates from causes exceeding design specifications.
   3. Mechanical damage caused by individuals, tools, or other outside agents.
   4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 PRODUCTS

2.1 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS

A. Silicone, S, NS, 100/50, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.
   1. Subject to compliance with requirements, provide the product indicated or one of the following:
      a. Dow Corning Corporation; 790 or 791.
      b. Pecora Corporation; PCS.
      c. Sika Corporation; Sikasil WS-295 or Sikasil WS-295 FPS.

2.3 LATEX JOINT SEALANTS

A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Pecora Corporation; AC-20.
      b. Sherwin-Williams Company (The); 850A Siliconized Acrylic Latex Caulk, 950A Siliconized Acrylic Latex Caulk, White, or PowerHouse Siliconized Acrylic Latex Sealant.
      c. Tremco Incorporated; Tremflex 834.

2.4 LIQUID JOINT SEALANTS

A. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 100/50, for Use T, NT; SWRI validation.
   1. Basis of Design Product: DOWSIL 790 Silicone Building Sealant.
   2. Hardness, ASTM C 661: 15 durometer Shore A.
   3. Volatile Organic Compound (VOC) Content: 26 g/L maximum.
   4. Staining, ASTM C 1248: None on concrete, granite, limestone, and brick.
   5. Color: As selected by Architect from manufacturer's full line of not less than 10 colors.

2.5 JOINT-SEALANT BACKING

A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. BASF Corporation.
      b. Construction Foam Products; a division of Nomaco, Inc.

B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin) Type O (open-cell material) Type B (bicellular material with a surface skin) or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.6 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
   1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
   2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
      a. Concrete.
      b. Masonry.
      c. Unglazed surfaces of ceramic tile.
   3. Remove laitance and form-release agents from concrete.
   4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
      a. Metal.
      b. Glass.
      c. Porcelain enamel.
      d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of sealant backings.
   2. Do not stretch, twist, puncture, or tear sealant backings.

3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
   4. Liquid Sealant Application: Install sealants using methods recommended by sealant manufacturer, in depths recommended for application. Apply in continuous operation from bottom to top of joint vertically and horizontally in a single direction. Apply using adequate pressure to fill and seal joint width.
   5. Tool sealants immediately with appropriately shaped tool to force sealants against joint backing and joint substrates, eliminating voids and ensuring full contact.
   6. Using tooling agents approved by sealant manufacturer for application.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
   1. Remove excess sealant from surfaces adjacent to joints.
   2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
   3. Provide concave joint profile per Figure 8A in ASTM C 1193 unless otherwise indicated.
   4. Provide flush joint profile at locations indicated on Drawings according to Figure 8B in ASTM C 1193.
   5. Provide recessed joint configuration of recess depth and at locations indicated on Drawings according to Figure 8C in ASTM C 1193.
      a. Use masking tape to protect surfaces adjacent to recessed tooled joints.
      b. Cleaning: Remove excess sealant using materials and methods approved by sealant manufacturer that will not damage joint substrate materials.
      c. Remove masking tape immediately after tooling joint without disturbing seal.
      d. Remove excess sealant from surfaces while still uncured.

3.4 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
   1. Extent of Testing: Test completed and cured sealant joints as follows:
      a. Perform 10 tests for the first 1000 feet of joint length for each kind of sealant and joint substrate.
   2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.

a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

3. Inspect tested joints and report on the following:
   a. Whether sealants filled joint cavities and are free of voids.
   b. Whether sealant dimensions and configurations comply with specified requirements.
   c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.
4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.
5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

B. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Final Acceptance. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.7 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.
   1. Joint Locations:
      a. Construction joints in cast-in-place concrete.
      b. Control and expansion joints in unit masonry.
      c. Joints between different materials listed above.

d. Perimeter joints between materials listed above and frames of doors windows and louvers.
e. Control and expansion joints in ceilings and other overhead surfaces.

2. Joint Sealant: Silicone, nonstaining, S, NS, 50, NT.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

B. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement.
1. Joint Locations:
a. Control joints on exposed interior surfaces of exterior walls.
b. Perimeter joints between interior wall surfaces and frames of interior doors windows.
2. Joint Sealant: Acrylic latex.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION 079200

SECTION 079219 - ACOUSTICAL JOINT SEALANTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes "Acoustic Joint Sealant or Spray: Material or combination of materials used to reduce the transmission of sound through non fire-rated assembly by providing an effective barrier against sound transmission through construction joint and through penetration openings."

B. Related Requirements:
   1. Section 079200 "Joint Sealants" for elastomeric, latex, and butyl-rubber-based joint sealants for non-acoustical applications.

1.3 ACTION SUBMITTALS

A. Product Data: For each acoustical joint sealant.

B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Samples for Verification: For each kind and color of acoustical joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Acoustical-Joint-Sealant Schedule: Include the following information:
   1. Joint-sealant application, joint location, and designation.
   2. Joint-sealant manufacturer and product name.
   3. Joint-sealant formulation.
   4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each kind of acoustical joint sealant, for tests performed by a qualified testing agency.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide acoustical joint-sealant products that effectively reduce airborne sound transmission through perimeter joints and openings in building construction, as demonstrated by testing representative assemblies according to ASTM E 90.

2.2 ACOUSTICAL JOINT SEALANTS

A. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard non-sag, paintable, non-staining latex acoustical sealant complying with ASTM C 834.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. GE Construction Sealants; Momentive Performance Materials Inc.
      b. Hilti, Inc.
      c. Pecora Corporation.
      d. Tremco Incorporated.
      e. United States Gypsum Company.
   2. Colors of Exposed Acoustical Joint Sealants: As selected by Architect from manufacturer's full range of colors.

2.3 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by acoustical-joint-sealant manufacturer where required for adhesion of sealant to joint substrates.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Non-staining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive acoustical joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing acoustical joint sealants to comply with joint-sealant manufacturer's written instructions.

B. Joint Priming: Prime joint substrates where recommended by acoustical-joint-sealant manufacturer. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF ACOUSTICAL JOINT SEALANTS

A. Comply with acoustical joint-sealant manufacturer's written installation instructions unless more stringent requirements apply.

B. Acoustical Ceiling Areas: Apply acoustical joint sealant at perimeter edge moldings of acoustical ceiling areas in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.

3.4 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of acoustical joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect acoustical joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Final Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated acoustical joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION 079219

SECTION 079513.16 - EXTERIOR EXPANSION JOINT COVER ASSEMBLIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Exterior expansion joint covers.

B. Related Requirements:

1.2 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for expansion joint cover assemblies.
   1. Exterior expansion joint covers.

B. Shop Drawings: For each expansion joint cover assembly.
   1. Include plans, elevations, sections, details, splices, block-out requirement, attachments to other work, and line diagrams showing entire route of each expansion joint.
   2. Where expansion joint cover assemblies change planes, provide isometric or clearly detailed drawing depicting how components interconnect.

C. Samples: For each exposed expansion joint cover assembly and for each color and texture specified, full width by 6 inches (150 mm) long in size.

D. Samples for Initial Selection: For each type of exposed finish.
   1. Include manufacturer's color charts showing the full range of colors and finishes available for each exposed metal and elastomeric seal material.

E. Samples for Verification: For each type of expansion joint cover assembly, full width by 6 inches (150 mm) long in size.

F. Expansion Joint Cover Assembly Schedule: Prepared by or under the supervision of the supplier. Include the following information in tabular form:
   1. Manufacturer and model number for each expansion joint cover assembly.
   2. Expansion joint cover assembly location cross-referenced to Drawings.
   3. Nominal, minimum, and maximum joint width.
   4. Movement direction.
   5. Materials, colors, and finishes.
   6. Product options.
   7. Fire-resistance ratings.

1.3 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each fire-resistance-rated expansion joint cover assembly, for tests performed by qualified testing agency.

1.4 MOCKUPS

A. Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.
   1. Build mockup of typical expansion joint cover assembly as shown on Drawings.
   2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Final Acceptance.

PART 2 PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Furnish units in longest practicable lengths to minimize field splicing.

B. Include factory-fabricated closure materials and transition pieces, T-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous expansion joint cover assemblies.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Expansion joint cover assemblies shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

B. Fire-Resistance Ratings: Provide expansion joint cover assemblies with fire barriers identical to those of systems tested for fire resistance according to UL 2079 or ASTM E1966 by a qualified testing agency.
   1. Hose Stream Test: Wall-to-wall and wall-to-soffit assemblies shall be subjected to hose stream testing.

C. Expansion Joint Design Criteria <079514.X>:
   1. Type of Movement: Thermal and Wind sway.
      a. Nominal Joint Width: As indicated on Drawings.
      b. Minimum Joint Width: As indicated on Drawings.
      c. Maximum Joint Width: As indicated on Drawings.
   2. Seismic Movement:
      a. Joint Movement: As indicated on Drawings.

2.3 EXTERIOR EXPANSION JOINT COVERS

A. Exterior Metal-Plate Joint Cover <079514.B>: Assembly consisting of sliding metal cover plate in continuous contact with gaskets mounted on metal frames fixed to sides of joint gap.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Balco.
      b. EMSEAL Joint Systems.
      c. LymTal International, Inc.
      d. Pecora Corporation.
   2. Application: Wall to wall, Wall to soffit.
   3. Installation: Recessed.
   4. Fire-Resistance Rating: Not less than that indicated on Drawings.
   5. Exposed Metal:
      a. Aluminum: Manufacturer's standard.
         1) Color: As selected by Architect from full range of industry colors and color densities.

B. Preformed Foam Joint Seals <079514.A>: Manufacturer's standard joint seal manufactured from urethane or EVA (ethylene vinyl acetate) foam with minimum density of 10 lb/cu. ft. (160 kg/cu. m) and impregnated with a nondrying, water-repellent agent. Factory produce in precompressed sizes in roll or stick form to fit joint widths based on design criteria indicated, with factory- or field-applied adhesive for bonding to substrates.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Balco.
      b. EMSEAL Joint Systems.
      c. LymTal International, Inc.
      d. Pecora Corporation.
   2. Design Criteria:
      a. Nominal Joint Width: As indicated on Drawings.
      b. Movement Capability: As indicated on Drawings.
   3. Joint Seal Color: As selected by Architect from full range of industry colors.

2.4 MATERIALS

A. Aluminum: ASTM B221 (ASTM B221M), Alloy 6063-T5 for extrusions; ASTM B209 (ASTM B209M), Alloy 6061-T6 for sheet and plate.
   1. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious materials.

B. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304 for plates, sheet, and strips.

C. Compression Seals: ASTM D2000; preformed rectangular elastomeric extrusions having internal baffle system and designed to function under compression.

D. Elastomeric Seals: Manufacturer's standard preformed elastomeric membranes or extrusions to be installed in metal frames.

E. Fire Barriers: Any material or material combination, when fire tested after cycling, designated to resist the passage of flame and hot gases through a movement joint and to comply with performance criteria for required fire-resistance rating.

F. Moisture Barrier: Manufacturer's standard, flexible elastomeric material - 7-ply laminate reinforced Polyethylene.

2.5 ALUMINUM FINISHES

A. Color Anodic Finish: AAMA 611, or thicker.

2.6 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
   1. Run grain of directional finishes with long dimension of each piece.
   2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
   3. Directional Satin Finish: No. 4.

2.7 ACCESSORIES

A. Moisture Barriers: Manufacturer's standard continuous, waterproof membrane within joint and attached to substrate on sides of joint.
   1. Provide where indicated on Drawings.

B. Manufacturer's stainless steel attachment devices. Include anchors, clips, fasteners, set screws, spacers, and other accessories compatible with material in contact, as indicated or required for complete installations.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces where expansion joint cover assemblies will be installed for installation tolerances and other conditions affecting performance of the Work.

B. Notify Architect where discrepancies occur that will affect proper expansion joint cover assembly installation and performance.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to expansion joint cover assembly manufacturer's written instructions.

B. Coordinate and furnish anchorages, setting drawings, and instructions for installing expansion joint cover assemblies. Provide fasteners of metal, type, and size to suit type of construction indicated and to provide for secure attachment of expansion joint cover assemblies.

3.3 INSTALLATION

A. Comply with manufacturer's written instructions for storing, handling, and installing expansion joint cover assemblies and materials unless more stringent requirements are indicated.

B. Metal Frames: Perform cutting, drilling, and fitting required to install expansion joint cover assemblies.
   1. Install in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
   2. Adjust for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation.
   3. Cut and fit ends to accommodate thermal expansion and contraction of metal without buckling of frames.
   4. Install frames in continuous contact with adjacent surfaces.
      a. Shimming is not permitted.
   5. Locate anchors at interval recommended by manufacturer, but not less than 3 inches (75 mm) from each end and not more than 24 inches (600 mm) o.c.

C. Elastomeric Seals: Install elastomeric seals and membranes in frames to comply with manufacturer's written instructions. Install with minimum number of end joints.
   1. Provide in continuous lengths for straight sections.
   2. Seal transitions. Vulcanize or heat-weld field-spliced joints as recommended by manufacturer.
   3. Mechanically lock seals into frames or adhere to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.

D. Preformed Foam Joint Seals: Install in compliance with manufacturer's written instructions. Install with minimum number of end joints.
   1. Install each length of seal immediately after removing protective wrapping.
   2. Firmly secure compressed joint seals to joint gap side to obtain full bond using exposed pressure-sensitive adhesive or field-applied adhesive as recommended by manufacturer.
   3. Do not pull or stretch material. Produce seal continuity at splices, ends, turns, and intersections of joints.
   4. For applications at low ambient temperatures, heat foam joint seal material in compliance with manufacturer's written instructions.

E. Install with hairline mitered corners where expansion joint cover assemblies change direction or abut other materials.

F. Terminate exposed ends of expansion joint cover assemblies with field- or factory-fabricated termination devices.

G. Fire-Resistance-Rated Assemblies: Coordinate installation of expansion joint cover assembly materials and associated work so complete assemblies comply with performance requirements.
   1. Fire Barriers: Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of joint, including transitions and field splices.

H. Moisture Barrier Drainage: If indicated, provide drainage fitting and connect to drains.

3.4 CONNECTIONS

A. Transition to Roof Expansion Joint Covers: Coordinate installation of exterior wall and soffit expansion joint covers with roof expansion joint covers specified in Section 077129 "Manufactured Roof Expansion Joints." Install factory-fabricated units at transition between exterior walls and soffits and roof expansion joint cover assemblies.

3.5 PROTECTION

A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.

B. Protect the installation from damage by work of other Sections.

END OF SECTION 079513.16

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:
   1. Interior standard steel doors and frames.
   2. Exterior standard steel doors and frames.

B. Related Requirements:
   1. Section 087100 "Door Hardware" for door hardware for hollow-metal doors.
   2. Section 134900 X-Ray Protection for lead-lined doors and door frames.

1.3 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.4 COORDINATION

A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, and finishes.

B. Shop Drawings: Include the following:
1. Elevations of each door type.
2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
7. Details of anchorages, joints, field splices, and connections.
8. Details of accessories.
9. Details of moldings, removable stops, and glazing.

C. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.7 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each type of hollow-metal door and frame assembly, for tests performed by a qualified testing agency.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use non-vented plastic.
1. Provide additional protection to prevent damage to factory-finished units.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow-metal doors and frames vertically under cover at Project site with head up. Place on minimum 4-inch- high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ceco Door; ASSA ABLOY.
2. Curries Company; ASSA ABLOY.
3. Pioneer Industries.
4. Steelcraft; an Allegion brand.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
   1. Smoke- and Draft-Control Assemblies: Provide assemblies with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.

B. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than 0.50 deg Btu/F x h x sq. ft. when tested according to ASTM C 518.

2.3 INTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Standard-Duty Doors and Frames: SDI A250.8, Level 1; SDI A250.4, Level C.
   1. Doors:
      a. Type: As indicated in the Door and Frame Schedule.
      b. Thickness: 1-3/4 inches.
      c. Face: Metallic-coated steel sheet, minimum thickness of 0.032 inch.
      d. Edge Construction: Model 1, Full Flush.
      e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
      f. Fire-Rated Core: Manufacturer's standard laminated mineral board core for fire-rated doors.
   2. Frames:
      a. Materials: Metallic-coated steel sheet, minimum thickness of 0.042 inch.
      b. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
      c. Construction: Full profile welded.
   3. Exposed Finish: Prime.

2.4 EXTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Heavy-Duty Doors and Frames: SDI A250.8, Level 2; SDI A250.4, Level B.
   1. Doors:
      a. Type: As indicated in the Door and Frame Schedule.
      b. Thickness: 1-3/4 inches.
      c. Face: Metallic-coated steel sheet, minimum thickness of 0.042 inch, with minimum A40coating.
      d. Edge Construction: Model 1, Full Flush.

e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
g. Bottom Edges: Close bottom edges of doors with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
h. Core: Manufacturer's standard.

2. Frames:
   a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A60 coating.
   b. Construction: Full profile welded.
3. Exposed Finish: Prime.

2.5 BORROWED LITES

A. Fabricate of metallic-coated steel sheet, minimum thickness of 0.053 inch.

B. Construction: Full profile welded.

C. Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as metal as frames.

D. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

2.6 FRAME ANCHORS

A. Jamb Anchors:
   1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
   2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches of frame height above 7 feet.
   3. Postinstalled Expansion Anchor: Minimum 3/8-inch- diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.

B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.

C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at top of underlayment.

D. Material: ASTM A 879/A 879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.
   1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M; hot-dip galvanized according to ASTM A 153/A 153M,

Class B.

2.7 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.

D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

F. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

G. Glazing: Comply with requirements in Section 088000 "Glazing."

2.8 FABRICATION

A. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.

B. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
   1. Sidelite and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding.
   2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
   3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
      a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
      b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

C. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.
   1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
   2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

D. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.
   1. Provide stops and moldings flush with face of door, and with square stops unless otherwise indicated.
   2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
   3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.
   4. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
   5. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

2.9 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
   1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 EXECUTION

3.1 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.

B. Drill and tap doors and frames to receive non-templated, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

A. General: Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.

B. Hollow-Metal Frames: Comply with SDI A250.11.
   1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.
      a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
      b. Install frames with removable stops located on secure side of opening.
   2. Fire-Rated Openings: Install frames according to NFPA 80.
   3. Floor Anchors: Secure with post-installed expansion anchors.
      a. Floor anchors may be set with power-actuated fasteners instead of post-installed expansion anchors if so indicated and approved on Shop Drawings.
   4. Solidly pack mineral-fiber insulation inside frames.
   5. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
   6. In-Place Concrete or Masonry Construction: Secure frames in place with post-installed expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
   7. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
      a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
      b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
      c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
      d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

C. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.
   1. Non-Fire-Rated Steel Doors: Comply with SDI A250.8.
   2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.

D. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.

3.3 CLEANING AND TOUCHUP

A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION 081113

SECTION 081416 - FLUSH WOOD DOORS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Solid-core doors with wood-veneer faces.
   2. Factory finishing flush wood doors.
   3. Factory fitting flush wood doors to frames and factory machining for hardware.

B. Related Requirements:
   1. Section 088000 "Glazing" for glass view panels in flush wood doors.
   2. Add Section 087100 "Door Hardware".

1.3 ACTION SUBMITTALS

A. Product Data: For each type of door. Include details of core and edge construction and trim for openings. Include factory-finishing specifications.

B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; and the following:
   1. Dimensions and locations of blocking.
   2. Dimensions and locations of mortises and holes for hardware.
   3. Dimensions and locations of cutouts.
   4. Undercuts.
   5. Requirements for veneer matching.
   6. Doors to be factory finished and finish requirements.
   7. Fire-protection ratings for fire-rated doors.
   8. Vinyl graphics on restroom doors.

C. Samples for Initial Selection: For factory-finished doors.

1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

B. Quality Standard Compliance Certificates: Program certificates.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of referenced standard and manufacturer's written instructions.

B. Package doors individually in plastic bags or cardboard cartons.

C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during remainder of construction period.

1.7 WARRANTY

A. A. Special Warranty: Manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
      b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
   2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
   3. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Graham Wood Doors.
   2. VT Industries Inc.
   3. Oshkosh Doors.

B. Source Limitations: Obtain flush wood doors from single manufacturer.

2.2 FLUSH WOOD DOORS, GENERAL

A. Quality Standard: In addition to requirements specified, comply with WDMA I.S.1-A, "Architectural Wood Flush Doors."
   1. Provide Labels indicating that doors comply with requirements of grades specified.

B. WDMA I.S.1-A Performance Grade: Heavy Duty.

C. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
   1. Cores: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
   2. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
   3. Pairs: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.

D. Structural-Composite-Lumber-Core Doors:
   1. ANSI A208.1, Grade LD-2 particleboard.
      a. Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware.

E. Mineral-Core Doors:
   1. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
   2. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated as needed to eliminate through-bolting hardware.
   3. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.
      a. Screw-Holding Capability: 550 lbf for Extra Heavy Duty and 475 lbf for Heavy Duty per WDMA T.M.-10.

2.3 VENEER-FACED DOORS FOR TRANSPARENT FINISH

A. Interior Solid-Core Doors:
   1. Grade: Premium, with Grade A faces.
   2. Species: Select white birch or maple.
   3. Cut: Plain sliced (flat sliced).
   4. Match between Veneer Leaves: Book match.
   5. Assembly of Veneer Leaves on Door Faces: Running match.
   6. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
   7. Room Match: Match door faces within each separate room or area of building. Corridor-door faces do not need to match where they are separated by 30 feet or more.
   8. Exposed Vertical and Top Edges: Same species as faces - edge Type A.
   9. Core: ANSI A208.1, Grade LD-2 particleboard.
   10. Construction: Five or seven plies. Stiles and rails are bonded to core, then entire unit is abrasive planed before veneering.

2.4 LIGHT FRAMES AND LOUVERS

A. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads unless otherwise indicated.
   1. Wood Species: Same species as door faces.
   2. Profile: Manufacturer's standard shape.

B. Metal Frames for Light Openings in Fire-Rated Doors: Manufacturer's standard frame formed of 0.048-inch- thick, cold-rolled steel sheet; with baked-enamel- or powder-coated finish; and approved for use in doors of fire-protection rating indicated.

2.5 FABRICATION

A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
   1. Comply with NFPA 80 requirements for fire-rated doors.

B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, BHMA-156.115-W, and hardware templates.
   1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
   2. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.

C. Openings: Factory cut and trim openings through doors.
   1. Light Openings: Trim openings with moldings of material and profile indicated.
   2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 088000 "Glazing."
   3. Louvers: Factory install louvers in prepared openings.

2.6 FACTORY FINISHING

A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
   1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.

B. Factory finish doors.

C. Transparent Finish:
   1. Grade: Premium.
   2. Finish: WDMA TR-4 conversion varnish or WDMA TR-6 catalyzed polyurethane.
   3. Staining: As selected by Architect from manufacturer's full range.

2.7 ACCESSORIES

A. Pressure Sensitive Vinyl (PSV) Graphics: vinyl image to applied to vertical door surface with manufacturer’s recommended moisture-resistant adhesive.
   1. Coordinate graphics with Architect.
   2. PSV Graphics to applied to single side of all restroom doors.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine doors and installed door frames, with Installer present, before hanging doors.
   1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
   2. Reject doors with defects.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Hardware: For installation, see Section 087100 "Door Hardware."

B. Installation Instructions: Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.
   1. Install fire-rated doors according to NFPA 80.

C. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

D. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 ADJUSTING

A. Operation: Rehang or replace doors that do not swing or operate freely.

B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 081416

SECTION 083113 - ACCESS DOORS AND FRAMES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes access doors and frames for walls and ceilings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details material descriptions, dimensions of individual components and profiles, and finishes.

B. Samples: For each type of access door and frame and for each finish specified, complete assembly minimum 6 by 6 inches (150 by 150 mm) in size.

C. Product Schedule: For access doors and frames.

PART 2 PRODUCTS

2.1 ACCESS DOORS AND FRAMES

A. Flush Access Doors with Concealed Flanges:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Acudor Products, Inc.
      b. Babcock-Davis.
      c. Cendrex Inc.
      d. JL Industries, Inc.; a division of the Activar Construction Products Group.
      e. Larsens Manufacturing Company.
      f. Nystrom.
   2. Description: Face of door flush with frame; with concealed flange for gypsum board installation and concealed hinge.
   3. Locations: Ceiling.
   4. Door Size: 30” x 30”.
   5. Uncoated Steel Sheet for Door: Nominal 0.060 inch (1.52 mm), 16 gage, factory primed.
   6. Frame Material: Same material and thickness as door.
   7. Latch and Lock: Cam latch, screwdriver operated.

2.2 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A879/A879M, with cold-rolled steel sheet substrate complying with ASTM A1008/A1008M, Commercial Steel (CS), exposed.

C. Frame Anchors: Same material as door face.

D. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A153/A153M or ASTM F2329.

2.3 FABRICATION

A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.

B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.
   1. For concealed flanges with drywall bead, provide edge trim for gypsum panels securely attached to perimeter of frames.

D. Latch and Lock Hardware:
   1. Quantity: Furnish number of latches required to hold doors tightly closed.

2.4 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
   1. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written instructions for installing access doors and frames.

3.3 FIELD QUALITY CONTROL

A. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

B. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

3.4 ADJUSTING

A. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION 083113

SECTION 083323 - OVERHEAD COILING DOORS

PART 1 GENERAL

1.1 SUMMARY

A. Work Results:

B. Principal Products:

1.2 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.3 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the overhead coiling doors as shown on the drawings and/or specified herein, including, but not limited to, the following:
   1. Overhead coiling doors, unrated.
   2. Hardware and accessories.
   3. Manual operation.

1.4 RELATED SECTIONS

A. Unit Masonry - Section 042000.

B. Miscellaneous Metals - Section 055000.

C. Finish Hardware - Section 087100.

D. Electrical - Division 26.

1.5 QUALITY ASSURANCE

A. Furnish each overhead coiling door as a complete unit produced by one manufacturer, including hardware, accessories, mounting and installation components.

B. Provide each type of overhead coiling door by one manufacturer for entire project.

C. Wind Loading: Design and reinforce exterior overhead coiling doors to withstand a thirty (30) lb. per square foot wind loading pressure, unless otherwise indicated.

1.6 SUBMITTALS

A. Product Data: Submit manufacturer’s product data, roughing-in diagrams, and installation instructions for each type and size of overhead coiling door. Include operating instructions and maintenance information.

B. Shop Drawings: Submit shop drawings for all special components, elements and installations which are not fully dimensioned or detailed on manufacturer’s data sheets.

C. Samples: Submit 12-inch long sample of curtain slat.

D. Finish Samples.
1. Samples for Initial Selection: Manufacturer's finish charts showing full range of colors and textures available for units with factory-applied finishes.
2. Samples for Verification: For each type of exposed finish required, prepared on Samples of curtain slats, 12 inches long.

1.7 PRODUCT HANDLING

A. Protection: Use all means necessary to protect the materials of this Section before, during and after installation and to protect the installed work and materials of all other trades.

B. Replacements: In the event of damage, immediately make all repairs and replacements.

1.8 WARRANTY

A. Door Warranty: Furnish one (1) year written warranty signed by the manufacturer and installer agreeing to repair or replace work which has failed as a result of defects in materials or workmanship. Upon notification within the warranty period, such defects shall be repaired at no cost to the Owner.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Provide "Model ESD10" overhead coiling doors manufactured by Cornell Iron Works/ Cookson, or equivalent by Overhead Door Corp., Raynor, or approved equal meeting these specifications and dimensions indicated in drawings.

2.2 DOOR CURTAIN MATERIALS AND CONSTRUCTION

A. Shutter Curtain: Fabricate overhead coiling door curtains of interlocking flat slats designed to withstand required wind loading, of continuous length for width of doors, without splices. Provide slats of structural quality, minimum twenty (20) gauge cold- rolled galvanized steel sheets complying with ASTM A 924, Grade A, with G90 zinc coating, complying with ASTM A 653, and phosphate treated before fabrication. Curtain slats shall be perforated with 0.062"

diameter openings at 0.094" staggered centers, approximately 22 per cent free area.

B. Bottom Bar: Consisting of two (2) extruded aluminum angles, each 1" x 3" high.

C. Endlocks: High-strength nylon, secured to curtain slats with galvanized rivets. Provide locks on alternate curtain slats for curtain alignment and resistance against lateral movement.

D. Windlocks: Malleable iron castings secured to curtain slats with galvanized rivets. Provide windlocks on overhead coiling doors approximately twenty-four (24) inches o.c. on both edges of curtain.

E. Curtain Jamb Guides: Fabricate curtain jamb guides of steel angles with sufficient depth and strength to retain curtain loading. Build up units with minimum 3/16" thick steel sections, hot-dip galvanized after fabrication. Slot bolt holes for track adjustment.
   1. Secure continuous wall angle to wall framing by 3/8" minimum bolts at not more than twenty-four (24) inches o.c. Extend wall angles above overhead coiling door opening head to support coil brackets, unless otherwise shown. Place anchor bolts on exterior wall guides so they are concealed when overhead coiling door is in closed position. Provide removable stops on guides to prevent over-travel of curtain, and continuous bar for holding windlocks.
   2. Hot-dip galvanize all angles and other steel elements in accordance with the specific hot-dip galvanization requirements under Section 055000.

F. Weather Seals: Provide vinyl or neoprene weatherstripping for exterior doors. At door heads, use 1/8" thick continuous sheet secured to inside of curtain coil hood. At door jambs, use 1/8" thick continuous strip secured to exterior side of jamb guide.

G. Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness. Custom color to be selected by the Architect.

2.3 COUNTERBALANCING MECHANISM

A. Counterbalance doors by means of adjustable steel helical torsion spring, mounted around a steel shaft and mounted in a spring barrel and connected to door curtain with required barrel rings. Use grease sealed bearings or self-lubricating graphite bearings for rotating members.

B. Counterbalance Barrel: Fabricate spring barrel of hot-formed structural quality carbon steel, welded or seamless pipe, of sufficient diameter and wall thickness to support curtain without distortion of slats and limit barrel deflection to not more than 0.03" per foot of span under full load.

C. Provide spring balance of one or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Provide cast steel barrel plugs to secure ends of springs to barrel and shaft.

D. Fabricate torsion rod for counterbalance shaft of cast-hardened steel, of required size to hold fixed springs ends and carry torsion load.

E. Brackets: Provide mounting brackets of manufacturer's standards design, either cast iron or cold-rolled steel plate with bell mouth guide groove for curtain.

F. Hood: Form to entirely enclose coiled curtain and operating mechanism at opening head, and act as weather seal. Contour to suit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Provide closed ends for surface- mounted hoods, and any portion of between-jamb mounting projecting beyond wall face. Provide intermediate support brackets as required to prevent sag.
   1. Fabricate steel hoods for doors of not less than twenty (20) gauge hot-dip galvanized steel sheet with G90 zinc coating, complying with ASTM A 525. Phosphate treat before fabrication.
   2. At fire rated assemblies furnish automatic drop baffle to guard against passage of smoke or flame.

2.4 INSERTS AND ANCHORAGES

A. Furnish inserts and anchoring devices which must be set in concrete or built into masonry for installation of units. Provide setting drawings, templates, instructions and directions for installation of anchorage devices. Coordinate delivery with other work to avoid delay.

B. Refer to concrete and masonry Sections of these specifications for installation of inserts and anchorage devices.

2.5 MANUAL DOOR OPERATORS

A. General: Equip door with manual door operator by door manufacturer.

B. Push-up Door Operation: Lift handles and pull rope for raising and lowering doors, with counterbalance mechanism designed so that required lift or pull for door operation does not exceed 25 lbf.

C. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.

D. Push/Pull Handles: Equip each push-up-operated or emergency-operated door with lifting handles on each side of door, finished to match door.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where overhead coiling doors are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 INSTALLATION

A. Install overhead coiling door and operating equipment complete with necessary hardware, jamb and head mold strips, anchors, inserts, hangers, and equipment supports in accordance with final shop drawings, manufacturer's instructions, and as specified herein.

B. Upon completion of installation, including work by other trades, lubricate, test and adjust overhead coiling doors to operate easily, free from warp, twist or distortion and fitting weather-tight for entire perimeter.

END OF SECTION 083323

SECTION 084113 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Storefront framing.
   2. Manual-swing entrance doors.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.
   1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
   2. Include full-size isometric details of each type of vertical-to-horizontal intersection of aluminum-framed entrances and storefronts, showing the following:
      a. Joinery, including concealed welds.
      b. Anchorage.
      c. Expansion provisions.
      d. Glazing.
      e. Flashing and drainage.
   3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
   4. Include point-to-point wiring diagrams showing the following:
      a. Power requirements for each electrically operated door hardware.
      b. Location and types of switches, signal device, conduit sizes, and number and size of wires.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

E. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.

F. Delegated-Design Submittal: For aluminum-framed entrances and storefronts indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and field testing agency.

B. Product Test Reports: For aluminum-framed entrances and storefronts, for tests performed by a qualified testing agency.

C. Quality-Control Program: Developed specifically for Project, including fabrication and installation, according to recommendations in ASTM C 1401. Include periodic quality-control reports.

D. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For aluminum-framed entrances and storefronts to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
   1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

1.8 MOCKUPS

A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
   1. Build mockup of typical wall area as shown on Drawings.
   2. Testing shall be performed on mockups according to requirements in "Field Quality Control" Article.
   3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures, including, but not limited to, excessive deflection.
      b. Noise or vibration created by wind and thermal and structural movements.
      c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
      d. Water penetration through fixed glazing and framing areas.
      e. Failure of operating components.
   2. Warranty Period: 10 years from date of Final Acceptance.

B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
   2. Warranty Period: 20 years from date of Final Acceptance.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, including framing spandrel panels and accessories, from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design aluminum-framed entrances and storefronts.

B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
   1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure, including, but not limited to, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
   2. Failure also includes the following:
      a. Thermal stresses transferring to building structure.
      b. Glass breakage.
      c. Noise or vibration created by wind and thermal and structural movements.
      d. Loosening or weakening of fasteners, attachments, and other components.
      e. Failure of operating units.

C. Structural Loads:
   1. Wind Loads: As indicated on Drawings.
   2. Other Design Loads: As indicated on Drawings.

D. Deflection of Framing Members: At design wind pressure, as follows:
   1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding 1/175 of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
   2. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 1/8 inch, whichever is smaller.
      a. Operable Units: Provide a minimum 1/16-inch clearance between framing members and operable units.

E. Structural: Test according to ASTM E 330/E 330M as follows:
   1. When tested at positive and negative wind-load design pressures, storefront assemblies, including entrance doors, do not evidence deflection exceeding specified limits.
   2. When tested at 150 percent of positive and negative wind-load design pressures, storefront assemblies, including entrance doors and anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
   3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

F. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:
   1. Fixed Framing and Glass Area:
      a. Maximum air leakage of 0.06 cfm/sq. ft. at a static-air-pressure differential of 6.24 lbf/sq. ft.
   2. Entrance Doors:
      a. Single Doors: Maximum air leakage of 0.5 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft.

G. Water Penetration under Static Pressure: Test according to ASTM E 331 as follows:
   1. No evidence of water penetration through fixed glazing and framing areas, including entrance doors, when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft.

H. Water Penetration under Dynamic Pressure: Test according to AAMA 501.1 as follows:
   1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft.
   2. Maximum Water Leakage: According to AAMA 501.1. Water leakage does not include water controlled by flashing and gutters, or water that is drained to exterior.

I. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.
   1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
   2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.
      a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F.
      b. Low Exterior Ambient-Air Temperature: 0 deg F.
      c. Interior Ambient-Air Temperature: 75 deg F.

2.3 STOREFRONT SYSTEMS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Oldcastle BuildingEnvelopeTM; Series 3000 or a comparable product by one of the following:
   1. Kawneer North America, an Arconic company.
   2. YKK AP America Inc; YES 600.
   3. U.S. Aluminum; a brand of C.R. Laurence.

B. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
   1. Exterior Framing Construction: Thermally broken.
   2. Interior Vestibule Framing Construction: Nonthermal.
   3. Glazing System: Retained mechanically with gaskets on four sides.
   4. Glazing Plane: Center Set.
   5. Finish: Clear Anodized.
   6. Fabrication Method: Field-fabricated stick system.
   7. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
   8. Steel Reinforcement: As required by manufacturer.

C. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.

D. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with non-staining, nonferrous shims for aligning system components.

E. Insulated Spandrel Panels: Comply with Section 084413.19 "Glazed Aluminum Curtain Walls."

2.4 ENTRANCE DOOR SYSTEMS

A. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing or automatic operation.
   1. Door Construction: 2- to 2-1/4-inch overall thickness, with minimum 0.125-inch- thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
      a. Thermal Construction: High-performance plastic connectors separate aluminum members exposed to the exterior from members exposed to the interior.
   2. Door Design: As indicated Wide stile; 5-inch nominal width.
   3. Glazing Stops and Gaskets: Beveled, snap-on, extruded-aluminum stops and preformed gaskets.
      a. Provide nonremovable glazing stops on outside of door.

2.5 ENTRANCE DOOR HARDWARE

A. Entrance Door Hardware: Hardware not specified in this Section is specified in Section 087100 "Door Hardware."

B. Cylinders: As specified in Section 087100 "Door Hardware."

2.6 GLAZING

A. Glazing: Comply with Section 088000 "Glazing."

B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.

C. Glazing Sealants: As recommended by manufacturer.

2.7 MATERIALS

A. Sheet and Plate: ASTM B 209.

B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.

C. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.

D. Structural Profiles: ASTM B 308/B 308M.

E. Steel Reinforcement:
   1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
   2. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
   3. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.
   4. Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and

pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.

2.8 ACCESSORIES

A. Automatic Door Operators: Section 087100 "Door Hardware."

B. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, non-staining, nonbleeding fasteners and accessories compatible with adjacent materials.
   1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
   2. Reinforce members as required to receive fastener threads.

C. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
   1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.

D. Concealed Flashing: Manufacturer's standard corrosion-resistant, non-staining, nonbleeding flashing compatible with adjacent materials.

E. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for 30-mil thickness per coat.

F. Rigid PVC Filler.

2.9 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:
   1. Profiles that are sharp, straight, and free of defects or deformations.
   2. Accurately fitted joints with ends coped or mitered.
   3. Physical and thermal isolation of glazing from framing members.
   4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
   5. Provisions for field replacement of glazing from interior for vision glass and exterior for spandrel glazing or metal panels.
   6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

E. Structural-Sealant-Glazed Framing Members: Include accommodations for using temporary support device to retain glazing in place while structural sealant cures.

F. Storefront Framing: Fabricate components for assembly using head-and-sill-receptor system with shear blocks at intermediate horizontal members.

G. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
   1. At interior and exterior doors, provide compression weather stripping at fixed stops.

H. Entrance Doors: Reinforce doors as required for installing entrance door hardware.
   1. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
   2. At exterior doors, provide weather sweeps applied to door bottoms.

I. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.

J. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.10 ALUMINUM FINISHES

A. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with AAMA 2604 and containing not less than 70 percent PVDF resin by weight in color coat.
   1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   2. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare surfaces that are in contact with structural sealant according to sealant manufacturer's written instructions, to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

3.3 INSTALLATION

A. General:
   1. Comply with manufacturer's written instructions.
   2. Do not install damaged components.
   3. Fit joints to produce hairline joints free of burrs and distortion.
   4. Rigidly secure nonmovement joints.
   5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
   6. Seal perimeter and other joints watertight unless otherwise indicated.

B. Metal Protection:
   1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
   2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Set continuous sill members and flashing in full sealant bed, as specified in Section 079200 "Joint Sealants," to produce weathertight installation.

D. Install components plumb and true in alignment with established lines and grades.

E. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.

F. Install glazing as specified in Section 088000 "Glazing."

G. Install weatherseal sealant according to Section 079200 "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.

H. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.
   1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
   2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

3.4 ERECTION TOLERANCES

A. Erection Tolerances: Install aluminum-framed entrances and storefronts to comply with the following maximum tolerances:
   1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
   2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
   3. Alignment:
      a. Where surfaces about in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.

b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.

4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Field Quality-Control Testing: Perform the following test on mockups.
1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.
a. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 10, 35, and 70 percent completion.
2. Air Infiltration: ASTM E 783 at 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article but not more than 0.09 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft.
a. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 10, 35, and 70 percent completion.
3. Water Penetration: ASTM E 1105 at a minimum uniform and cyclic static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft., and shall not evidence water penetration.

C. Aluminum-framed entrances and storefronts will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 084113

SECTION 084333 - FOLDING GLASS WALL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Folding glass wall systems.

1.2 RELATED SECTIONS

A. Section 033000 - Cast-in-Place Concrete.

B. Section 054000 - Cold-Formed Metal Framing.

C. Section 061000 - Rough Carpentry.

D. Section 062000 - Finish Carpentry.

E. Section 076000 - Flashing and Sheet Metal.

1.3 REFERENCES

A. American Welding Society (AWS): Structural Welding Code.

B. ASTM International (ASTM):
1. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wires, Profiles, and Tubes.
2. ASTM B241 - Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tubes.
3. ASTM C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
4. ASTM E1996 - Standard Specification For Performance Of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris In Hurricanes.

C. Fenestration and Glazing Industry Alliance (FGIA):
1. AAMA 611 - Voluntary Specifications for Anodized Architectural Aluminum.
2. AAMA 1503 - Voluntary Test Method For Thermal Transmittance And Condensation Resistance Of Windows, Doors, And Glazed Wall Sections.

D. Glass Association of North America (GANA): Glazing manual.

1.4 SUBMITTALS

A. Product Data:
   1. Manufacturer's data sheets on each product to be used.
   2. Preparation instructions and recommendations.
   3. Storage and handling requirements and recommendations.
   4. Typical installation methods.

B. Selection Samples: Two complete color chip sets representing manufacturer's full range of stocked colors with a standard size of 2 x 3 inches (50 x 75 mm).

C. Verification Samples: Two representative units of each type, size, color and finish.
   1. Aluminum Finish: Two samples, minimum size of 2 x 3 inches (50 x 75 mm), representing actual material and color.
   2. Wood Finish: Two samples, minimum size of 2 x 5 inches (50 x 127 mm), representing actual product and color.
   3. Glazing: Two samples, minimum size of 12 x 12 inches (300 x 300 mm), representing specified glass, including coatings and frit patterns.
   4. Assembly Sample: One sample demonstrating connection details with a maximum size of 12 x 12 x 12 inches (305 x 305 x 305 mm). Glazing included as offered by glass supplier. Sample developed to best represent the specified product.

D. Shop Drawings: Detailed drawings prepared specifically for the project by manufacturer. Include information not fully detailed in manufacturer's standard product data, including, but not limited to wall elevations and detail sections of every typical composite member.
   1. Show opening dimensions, framed opening tolerances, profiles, product components, anchorages, and accessories.
   2. Include details of materials, construction, finish, fastener locations, glazing, hardware arrangements and relationship with adjacent construction.
   3. Include schedule identifying each unit, with marks or numbers referencing Drawings.
   4. Show surrounding substrates and relevant conditions.

E. Maintenance Manuals: Manufacturer's maintenance manuals.

F. Warranty: Manufacturer's warranty online registry.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with a minimum twenty (20) years documented experience in fabrication and erection of glass wall systems for projects of similar scope.
   1. Manufacturer must use an extruded aluminum system comprised of domestically produced aluminum and is fabricated and assembled in the USA.
   2. Manufacturer must be recognized by NAMI.
   3. Manufacturer must be a member in good standing of the National Glass Association (NGA).

B. Installer Qualifications: Company experienced in performing work of this section that has specialized in installation of work similar in scope and complexity required for this project for

a minimum of five (5) years.

C. Source Limitations: Provide each type of product from a single manufacturing source to ensure uniformity.

1.6 PRE-INSTALLATION CONFERENCE

A. Convene a conference, by phone, approximately two weeks before scheduled commencement of the Work. Attendees will include Architect, Contractor and trades involved. Agenda will include schedule, responsibilities, critical path items and approvals.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store and handle in strict compliance with manufacturer's written instructions and recommendations. Store products in manufacturer's original unopened packaging, covered to protect factory finishes from damage, precipitation, and construction dirt until ready for installation. Store materials off construction grounds in a secure location that is a dry, covered area and protected from weather conditions.

B. Inspect and report any freight damages to the manufacturer immediately.

C. Protect from damage due to weather, excessive temperature, and construction operations.

1.8 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

B. Perform structural silicone sealant work when air temperature is above 10 degrees F (minus 12 degrees C). 40 - 120 degrees F (4 - 49 degrees C) is ideal.

1.9 WARRANTY

A. Manufacturer's Warranty: Provide manufacturer's standard limited warranty against defects in materials and workmanship.
   1. Warranty Period for Glass Wall Systems: 10 years for cases of normal use.
   2. Warranty Period for Bearing Assemblies: Free from defect for a period of 10 years.
   3. Warranty Period for Trolley and Hinge Assemblies: Free from defect for a period of 10 years.
   4. Warranty for Frame Finish:
      a. Anodized Finishes: Provide a warranty of 5 years.
      b. Stock Color AAMA 2605 Finishes: 2-3 coats powder or liquid dependent on color and/or application, provide paint manufacturer's warranty for color and film integrity for at least 15 years from date of application.

c. Custom Color AAMA 2605 Finishes: 2-3 coats powder or liquid dependent on color and/or application, provide paint manufacturer's warranty for color and film integrity for at least 15 years from date of application.
d. Stock Color AAMA 2604 Finishes: 2 coats powder or liquid, provide warranty for color and film integrity for 10 years from date of application.
e. Custom Color AAMA 2604 Finishes: 2 coats powder or liquid, provide paint manufacturer's warranty for cracking and pulling integrity for 10 years from date of application.
f. Custom AAMA 2603 Finishes: 1 coat liquid only, thermosetting acrylic resin finishes, provide warranty for cracking and pulling integrity for 5 years from date of application.
g. Stock Color AAMA 2603 Finishes: 1 coat liquid only, provide paint manufacturer's warranty for cracking and pulling integrity for at least 5 years from date of application.

5. Warranty for Flat Glazing: Provide glazing manufacturer's standard warranty against defective materials, delamination, seal failure, and defects in manufacturing for up to 20 years prorated or as otherwise provided in or limited by the glass manufacturer's limited warranty.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Nanawall SL70 or comparable product by one of the following:
1. Solar Innovations Architectural.
2. Euro-Wall.
3. Modern Fold Styles.

2.2 PERFORMANCE REQUIREMENTS

A. Air Leakage Performance:
1. Design, fabricate, assemble, and erect the aluminum glazed system to be permanently free of significant air leakage.
2. Significant leakage to be defined as a differential test pressure amounting to 20 percent of specified strength performance pressure required with operable windows doors, or joints, if any, sealed to prevent crack leakage.

B. Structural Performance: Structural performance as tested in accordance with ASTM E330; with no glass breakage or permanent damage to fasteners, anchors, hardware, or actuating mechanisms.
1. Normal wall deflection not exceeding 1/175 of clear span for span lengths of 162 inches (4115 mm) or less and 1/240 plus 1/4 inch (6 mm) for others. Restrict deflection to 3/4 inch (19 mm) maximum for individual glazing lites.
2. Parallel to wall deflection not exceeding 175 percent of glass edge clearance. Restrict deflection to L/360 or 1/8 inch (3 mm) maximum. Restrict deflection to 1/16 inch (1.6 mm) maximum above doors and/or windows. Increasing the deflection to 1/8 inch (3

mm) to be permitted if the unit operation is not affected.

3. Deflection of the entire assembly, including, but not limited to, glass, not to exceed 1-1/2 inches (38 mm).

C. Thermal Performance: Tested values, certifications, and simulation protocols.
   1. Thermal Characteristics:
      a. U-Value:
      b. CRF: ___.
   2. U-Value: Unit complies with U-value, NFRC rating, or simulation in accordance with NFRC 100 protocol, shown in manufacturer's published data for glazing and sill specified.
   3. Solar Heat Gain Coefficient: Unit to comply with the Solar Heat Gain Coefficient NFRC rated, or simulation in accordance with NFRC 200 protocol, shown in manufacturers published data for the glazing and sill specified.

D. Compliance:
   1. Folding Wall System: SI33350F Impact Infold and/or Outfold Wall System as manufactured by Solar Innovations Architectural Glazing Systems; when tested on a typical size panel folding wall unit size of (W x H) 260.69 x 118.5 inches (6621.5 x 3009.9 mm); panel size of (W x H) 42 x 114 inches (1067 x 2896 mm).
      a. Testing Results for Wall System: Mid-Wall Double Door Infold Folding Glass Wall; FL Approval No. 13407.4.
         1) High Velocity Hurricane Zone Flush Sill Rating (NCTL 110-15505-1).
            a) Air Infiltration Test per ASTM E283: Force of 1.6 psf (75 Pa), 0.09 cfm per sq ft (27.4 L per min per sq m) infiltration.
            b) Water Penetration Test per ASTM E331: Water pressure of 9.0 psf (431 Pa) at 5.0 gal per hour per sq ft (204 L per hour per sq m), no leakage.
            c) Structural testing per ASTM E330:
         2) Design Pressure: Positive or negative 55 psf (2633 Pa).
         3) High Velocity Hurricane Zone Standard Sill Rating (NCTL 110-15327-1).
            a) Air Infiltration Test per ASTM E283: Force of 1.6 psf (75 Pa), 0.02 cfm per sq ft (6.1 L per min per sq m) infiltration.
            b) Water Penetration Test per ASTM E331: Water pressure of 9.0 psf (431 Pa) at 5.0 gal per hour per sq ft (204 L per hour per sq m), no leakage.
            c) Structural testing per ASTM E330:
         4) Design Pressure: Positive or negative 70 psf (3352 Pa).
      b. Testing Results for Wall System: Mid-Wall Double Door Outfold Folding Glass Wall; FL Approval No. 13407.5.
         1) High Velocity Hurricane Zone Flush Sill Rating (NCTL 110-15505-1).
            a) Air Infiltration Test per ASTM E283: Force of 1.6 psf (75 Pa), 0.09 cfm per sq ft (27.4 L per min per sq m) infiltration.
            b) Water Penetration Test per ASTM E331: Water pressure of 9.0 psf (431 Pa) at 5.0 gal per hour per sq ft (204 L per hour per sq m), no leakage.
            c) Structural testing per ASTM E330:
         2) Design Pressure: Positive or negative 55 psf (2633 Pa).
         3) High Velocity Hurricane Zone Standard Sill Rating (NCTL 110-15327-1).
            a) Air Infiltration Test per ASTM E283: Force of 1.6 psf (75 Pa), 0.18 cfm per sq ft (54.9 L per min per sq m) infiltration.

b) Water Penetration Test per ASTM E331: Water pressure of 12.0 psf (574.5 Pa) at 5.0 gal per hour per sq ft (204 L per hour per sq m), no leakage.
c) Structural testing per ASTM E330:

4) Design Pressure: Positive or negative 70 psf (3352 Pa).

2. Folding Wall System: SI3350 Non-impact Infold and/or Outfold Wall System as manufactured by Solar Innovations Architectural Glazing Systems; when tested on a typical size panel folding wall unit size of (W x H) 223.75 x 100.5 inches (5683 x 2553 mm) - panel size of (W x H) 36 x 96 inches (914 x 2438 mm); and 149.9375 x 100.5 inches (3808.4125 x 2553 mm).
   a. Testing Results for Infold Wall System: 90 degree Corner No Post Folding Glass Wall; FL Approval No. 12279.3.
      1) Flush Sill Rating (NCTL 110-15540-1).
         a) Air Infiltration Test per ASTM E283: Force of 1.6 psf (75 Pa), 0.08 cfm per sq ft (24 L per min per sq m) infiltration.
         b) Water Penetration Test per ASTM E331: Water pressure of 9.0 psf (431 Pa) at 5.0 gal per hour per sq ft (204 L per hour per sq m), no leakage.
         c) Structural testing per ASTM E330:
      2) Design Pressure: Positive 70 psf (2873 Pa) to negative 70 psf (3352 Pa).
      3) Standard Sill Rating (NCTL 110-14992-1).
         a) Air Infiltration Test per ASTM E283: Force of 1.6 psf (75 Pa), 0.05 cfm per sq ft (15.2 L per min per sq m) infiltration.
         b) Water Penetration Test per ASTM E331: Water pressure of 9.0 psf (431 Pa) at 5.0 gal per hour per sq ft (204 L per hour per sq m), no leakage.
         c) Structural testing per ASTM E330:
      4) Design Pressure: Positive or negative 80 psf (3830 Pa).
   b. Testing Results for Outfold Wall System: All Wall Folding Glass Wall; FL Approval No. 12279.5.
      1) Flush Sill Rating (NCTL 110-15135-1, NCTL 110-15540-1).
         a) Air Infiltration Test per ASTM E283: Force of 1.6 psf (75 Pa), 0.08 cfm per sq ft (24 L per min per sq m) infiltration.
         b) Water Penetration Test per ASTM E331 and ASTM E547: Water pressure of 9.0 psf (431 Pa) at 5.0 gal per hour per sq ft (204 L per hour per sq m), no leakage.
         c) Structural testing per ASTM E330:
      2) Design Pressure: Positive 70 psf (2873 Pa) to negative 70 psf (3352 Pa).
      3) Design Pressure with Panic Bar Option: Positive or negative 65 psf (3112 Pa).
      4) Standard Sill Rating (NCTL 110-15135-1, NCTL 110-14994-1).
         a) Air Infiltration Test per ASTM E283: Force of 1.6 psf (75 Pa), less than 0.01 cfm per sq ft (3.0 L per min per sq m) infiltration.
         b) Water Penetration Test per ASTM E331 and ASTM E547: Water pressure of 15.0 psf (718 Pa) at 5.0 gal per hour per sq ft (204 L per hour per sq m), no leakage.
         c) Structural testing per ASTM E330:
      5) Design Pressure: Positive or negative 80 psf (3830 Pa).
      6) Design Pressure with Panic Bar Option: Positive or negative 65 psf (3112 Pa).

2.3 GLASS WALL SYSTEMS

A. Glass Wall Systems:
1. Basis of Design: SI33350F G3 folding wall system as manufactured by Solar Innovations Architectural Glazing Systems, regular thermal extruded aluminum frame with a thermal isolation separation 2.75 inches (69.85 mm) width.
2. Framing Members Thickness: Thickness as determined by manufacturer based on design loading, cross sectional configuration, and fabrication requirements.
3. Load Bearing: As indicated on Drawings.
4. Operation: In-folding system.
5. Configuration: For folding wall systems, single door.
6. Panel Size: As indicated on Drawings.
7. Panel Size:
   a. Width _____.
   b. Height _____.
8. Mullions: Standard mullion, 3-1/2 inches (89 mm) for G2 wall systems.
9. Perimeter Weather Gaskets: EPDM with solid strand cord.
10. Sills: ADA surface mount sill.
11. Drain Tubes: Factory fabricated. top load only. Field fabricated drain tubes are not acceptable.

B. Hardware:
1. For Folding or Slide and Stack Glass Wall Systems:
   a. Pulls: Low profile handle.
      1) Finish: Class 1 clear anodized.
   b. Hinges: Surface mount aluminum hinge with stainless steel bushings and security bolt end; 7-knuckle, aluminum and stainless steel, corrosion proof, Zinc-die-cast hinges not acceptable.
      1) Finish: Class 1 clear anodized.
   c. Locks: Two point keyed lock.
      1) Finish: Class 1 clear anodized.
   d. Closers: C Series PR82 top mounted door closer.
      1) Finish: Mill finish aluminum.
   e. Door Limiters: In locations as scheduled and indicated on Drawings.
   f. Commercial Panic Hardware: Exterior Entry Trim.
   g. Commercial Panic Hardware: Mortise panic.
   h. Passive Hardware: Square style for commercial applications.
2. For Clear Glass Wall Systems:
   a. Closers: C Series PR82 top mounted door closer.
      1) Finish: Mill finish aluminum.
   b. Adjustable Door Catches:
      1) Finish: Class 1 clear anodized.
   c. Door Limiters: In locations as scheduled and indicated on Drawings.
   d. Hinges: Clear FGW hinges.
      1) Finish: Class 1 clear anodized.
   e. Bottom Locks: Keyed locks.
3. Stainless Steel Bearings: With eight rollers which can be serviced without being removed from their track system.
4. Stainless Steel Bearings: With rollers which can be serviced without being removed from

their track system.

5. Fasteners: For applications in locations as approved by manufacturer.
6. Locking Rods: Concealed stainless steel locking rods; aluminum locking rods not acceptable.
7. Corners:
   a. Corner Lugs: Extruded aluminum, with thermal break.
   b. Corner Connectors: With thermal break.
8. End Caps: Do not breech thermal break.

C. Materials:
1. Aluminum Flashing and Closures:
   a. Alloy and Temper: 6063-T52, 6063-T6, or 6061-T6.
   b. Sheet Aluminum Finish: Matching system components.
   c. Thickness: Minimum 0.040 inch (1 mm) thick.
   d. Attachment: Secured with concealed fastening method or fastener with head finished to match system components.
   e. Snap-on Covers and Miscellaneous Non-Structural Trim: Minimum thickness as recommended by manufacturer.
2. Insulation: Expanded polystyrene insulation at filler panels and sheet metal members.
3. Thermal Breaks: Thermal Insulbar Separation, manufacturer's standard system to provide thermal separation between exterior and interior components.
4. Internal Reinforcing: Structural aluminum complying with ASTM B221 and ASTM B241.
5. Structural Glazing Sealant: Manufacturer's standard, black.
6. Perimeter Sealant: Manufacturer's standard, color as selected from manufacturer's standard range.
7. Glazing: Double pane glazing, 1 inch (25 mm) insulated glass unit.
   a. Outboard Glazing Lites: 3/16 inch (5 mm) tempered clear glass with LoE 272 low-emissivity coating on surface two.
      1) Visible Light Transmittance: 72 percent.
      2) Solar Heat Gain Coefficient: 0.41.
   b. Vertical Inboard Glazing Lites: 3/16 inch (5 mm) tempered clear glass.
   c. Air Spacers: Stainless steel spacer with dual seals of polyisobutylene/silicone and filled with argon gas.
8. Glazing Gaskets: Compatible with glazing sealant.
   a. Compliance: ASTM C864.
   b. Design Compression type, replaceable, EPDM gaskets; with and without solid strand cord to prevent shrinkage.
   c. Color: Manufacturer's standard, black.
   d. Corners: Factory molded corners required at interior.
9. Setting Blocks, Edge Blocks, and Spacers: As recommended by manufacturer and compatible with insulated glass.
10. Gaskets: H Clear wall seal, translucent PVC, for folding clear glass wall systems.
11. Fasteners: Aluminum and stainless steel, not causing electrolytic action or corrosion.
12. Finish for Exposed Fasteners: To match finish of aluminum frame.

D. Finishes:
1. Aluminum Wall Frames: Manufacturer's standard clear anodized finish, Class I AAMA 611.

E. Fabrication:
1. Fabricate components in accordance with approved Shop Drawings.
2. Major fabrication must done at the manufacturing location.
3. Install gaskets and tapes at factory.
4. Disassemble only to the extent necessary for shipping and handling limitations.
5. Manufacturer is to be notified of any field modification prior to the activity commencing.
6. Welding is to comply with standards set forth by the American Welding Society.
7. Factory-grind exposed welds smooth and flush with adjacent surfaces prior to finish application; restore mechanical finish.
8. Isolation membrane materials to be used to separate dissimilar metals to prevent galvanic corrosion/action between materials.
9. Fabricate components to allow for accurate and rigid fit of joints and corners. Match components carefully ensuring continuity of line and design. Ensure joints and connections will be flush and weather tight. Ensure slip joints make full, tight contact and are weathertight.
10. Fabricate components true to detail and free from defects impairing appearance, strength or durability.
11. Provide contoured exterior horizontal or purlin glazing retainers to minimize water, ice, and snow buildup.
12. Fabricate with removable sill and head stop.
13. Reinforce components at anchorage and support points, joints, and attachment points for interfacing work.
14. Accurately size glazing to fit openings allowing for clearances as set forth by the "Glazing Manual" published by the Glass Association of North America (GANA).
15. Cut glass clean and carefully. Nicks and damaged edges will not be accepted. Replace glass with damaged edges.

PART 3 EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Prepare substrates in strict accordance with the approved Shop Drawings, using the methods recommended by the manufacturer for achieving best result for the substrates under project conditions. Thoroughly clean surfaces and substrates prior to installation.

B. Do not proceed with installation until substrates have been prepared using the methods recommended by the manufacturer and deviations from manufacturer's recommended tolerances are corrected. Commencement of installation constitutes acceptance of conditions.

C. Verify the structural integrity or the header such that the maximum deflection with both the live and dead loads is limited to be less than 1/8 inch (3 mm). Provide structural support for lateral wind loading. A maximum vertical deflection of greater than 1/8 inch (3 mm) per request may be allowable if accepted by manufacturer. Any deflections larger than 1/8 inch (3 mm) that is requested must be reevaluated and analyzed for engineering approval.

D. If preparation is the responsibility of another installer, notify Architect in writing of deviations from manufacturer's recommended installation tolerances and conditions.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions, approved submittals and in proper relationship with adjacent construction.
   1. Separate dissimilar materials using nonconductive tape, paint, or other material not visible in finished work.
   2. Provide attachments and shims to permanently fasten system to building structure.
   3. Maintain dimensional tolerances and alignment with adjacent work.
   4. Anchor securely in place, allowing for required movement, including but limited to expansion and contraction.
   5. Install glazing sealants in accordance with manufacturer's instructions, including but not limited to surface preparations.
   6. Set sill members in bed of sealant. Set other members with internal sealants to provide weather tight construction.
   7. Install flashings, bent metal closures, corners, gutters, and other accessories as detailed on Shop Drawings and required for complete installation.
   8. Clean surfaces and install sealant in accordance with sealant manufacturer's instructions and guidelines.

3.3 FIELD QUALITY CONTROL

A. Field Inspection: Coordinate field inspection in accordance with appropriate sections in Division 01.

B. Manufacturer's Services: Coordinate manufacturer's services in accordance with appropriate sections in Division 01.

3.4 TESTING AND ADJUSTING

A. Adjust hinge set, locksets, and other hardware for proper operation.

B. Lubricate using a manufacturer approved lubricant compatible with frame coatings.

3.5 CLEANING AND PROTECTION

A. Clean and protect products in accordance with the manufacturer's recommendations.
   1. Remove temporary coverings and protection of adjacent work areas.
   2. Clean and dress sealant prior to installation completion.
   3. Clean glass prior to installation completion.
   4. Clean the entire enclosure one time at the completion of the installation. Cleaning to include surface cleaning of aluminum framing and glass and cleanup of construction debris.

B. Touch-up, repair or replace damaged products before Final Acceptance.
   1. Areas with Abraded Surface Finish: Clean and touch-up with air dry paint, as approved and furnished by window manufacturer, color to match factory applied finish.

END OF SECTION 084333

SECTION 084413 - GLAZED ALUMINUM CURTAIN WALLS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes glazed aluminum curtain walls.

B. Related Requirements:

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For glazed aluminum curtain walls. Include plans, elevations, sections, full-size details, and attachments to other work.
   1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
   2. Include full-size isometric details of each vertical-to-horizontal intersection of glazed aluminum curtain walls, showing the following:
      a. Joinery, including concealed welds.
      b. Anchorage.
      c. Expansion provisions.
      d. Glazing.
      e. Flashing and drainage.
   3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

E. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from 12-inch lengths of full-size components and showing details of the following:
   1. Joinery, including concealed welds.
   2. Anchorage.
   3. Expansion provisions.
   4. Glazing.
   5. Flashing and drainage.

F. Delegated-Design Submittal: For glazed aluminum curtain walls indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Preconstruction Laboratory Mockup Testing Submittals:
   1. Testing Program: Developed specifically for Project.
   2. Test Reports: Prepared by a qualified preconstruction testing agency for each mockup test.
   3. Record Drawings: As-built drawings of preconstruction laboratory mockups showing changes made during preconstruction laboratory mockup testing.

B. Qualification Data: For Installer and field testing agency.

C. Energy Performance Certificates: For glazed aluminum curtain walls, accessories, and components from manufacturer.
   1. Basis for Certification: NFRC-certified energy performance values for each glazed aluminum curtain wall.

D. Product Test Reports: For glazed aluminum curtain walls, for tests performed by a qualified testing agency.

E. Quality-Control Program: Developed specifically for Project, including fabrication and installation, according to recommendations in ASTM C 1401. Include periodic quality-control reports.

F. Source quality-control reports.

G. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For glazed aluminum curtain walls to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025.

C. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
   1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

D. Structural-Sealant Glazing: Comply with ASTM C 1401 for design and installation of curtain wall assemblies.

1.8 MOCKUPS

A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
   1. Build mockup of typical wall area as shown on Drawings.
   2. Testing shall be performed on mockups according to requirements in "Field Quality Control" Article.
   3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.9 WARRANTY

A. Special Assembly Warranty: Manufacturer agrees to repair or replace components of glazed aluminum curtain wall that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including, but not limited to, excessive deflection.
      b. Noise or vibration created by wind and thermal and structural movements.
      c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
      d. Water penetration through fixed glazing and framing areas.
      e. Failure of operating components.
   2. Warranty Period: 10 years from date of Final Acceptance.

B. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.
   1. Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
      c. Cracking, peeling, or chipping.
   2. Warranty Period: 10 years from date of Final Acceptance.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design glazed aluminum curtain walls.

B. General Performance: Comply with performance requirements specified, as determined by testing of glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
   1. Glazed aluminum curtain walls shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
   2. Failure also includes the following:
      a. Thermal stresses transferring to building structure.
      b. Glass breakage.
      c. Noise or vibration created by wind and thermal and structural movements.
      d. Loosening or weakening of fasteners, attachments, and other components.
      e. Failure of operating units.

C. Structural Loads:
   1. Wind Loads: As indicated on Drawings.
   2. Other Design Loads: As indicated on Drawings.

D. Deflection of Framing Members: At design wind pressure, as follows:
   1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding 1/175 of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
   2. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 1/8 inch, whichever is smaller.
      a. Operable Units: Provide a minimum 1/16-inch clearance between framing members and operable units.
   3. Cantilever Deflection: Where framing members overhang an anchor point, as follows:
      a. Perpendicular to Plane of Wall: No greater than 1/240 of clear span plus 1/4-inch for spans greater than 11 feet 8-1/4 inches or 1/175 times span, for spans less than 11 feet 8-1/4 inches.

E. Structural: Test according to ASTM E 330 as follows:
   1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
   2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
   3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

F. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:
   1. Fixed Framing and Glass Area:

a. Maximum air leakage of 0.06 cfm/sq. ft. at a static-air-pressure differential of 6.24 lbf/sq. ft.

G. Water Penetration under Static Pressure: Test according to ASTM E 331 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft.

H. Water Penetration under Dynamic Pressure: Test according to AAMA 501.1 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft.
2. Maximum Water Leakage: According to AAMA 501.1. Water leakage does not include water controlled by flashing and gutters, or water that is drained to exterior.

I. Energy Performance: Certify and label energy performance according to NFRC as follows:
1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.45 Btu/sq. ft. x h x deg F as determined according to NFRC 100.
2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than.25 as determined according to NFRC 200.
3. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC-certified condensation resistance rating of no less than 15 as determined according to NFRC 500.

J. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:
1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.
a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F.
b. Low Exterior Ambient-Air Temperature: 0 deg F.

2.2 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide YKK AP America Inc.; or a comparable product by one of the following:
1. Kawneer North America, an Arconic company.
2. Oldcastle, Inc.
3. U.S. Aluminum; a brand of C.R. Laurence.

B. Source Limitations: Obtain all components of curtain wall system, including framing spandrel panels entrances and accessories, from single manufacturer.

2.3 FRAMING

A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
   1. Construction: Thermally improved.
   2. Glazing System: Retained mechanically with gaskets on four sides.
   3. Glazing Plane: Front.
   4. Finish: Clear Anodized.
   5. Fabrication Method: Either factory- or field-fabricated system.
   6. Framing Depths: 7 ½" and 10 ½" - see drawings.

B. Pressure Caps: Manufacturer's standard aluminum components that mechanically retain glazing.
   1. Include snap-on aluminum trim that conceals fasteners.

C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with non-staining, nonferrous shims for aligning system components.

D. Materials:
   1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
      a. Sheet and Plate: ASTM B 209.
      b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
      c. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
      d. Structural Profiles: ASTM B 308/B 308M.
   2. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
      a. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
      b. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
      c. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

2.4 ENTRANCES

A. Entrances: Comply with Section 084113 "Aluminum-Framed Entrances and Storefronts."

2.5 SUN CONTROL

A. Sunshades: Assemblies consisting of curtainwall manufacturer's standard single blade system and mounting brackets, designed for attachment to curtainwall with mechanical fasteners.
   1. Orientation: Horizontal and Vertical, As indicated on Drawings.
   2. Projection from Wall: As indicated on Drawings.
   3. Outriggers: 1/4" flat aluminum plate members with front edge to match blade profiles. Single end plates required at the ends of each sunshade run.
   4. Mounting Brackets: Manufacturer's standard extruded aluminum mounting brackets with stainless steel mounting hardware as required to support imposed loads.

5. Blades: Manufacturer's standard extruded or formed-aluminum framing members of thickness required to support imposed loads.
   a. Number: As indicated on Drawings.
   b. Shape: Airfoil.
   c. Width: As indicated on Drawings.
   d. Mounting Angle: As indicated on Drawings.
6. Finish: Clear anodic finish.

B. Materials:
   1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
      a. Sheet and Plate: ASTM B 209.
      b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
      c. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
      d. Structural Profiles: ASTM B 308/B 308M.

2.6 GLAZING

A. Glazing: Comply with Section 088000 "Glazing."

B. Glazing Gaskets: Comply with Section 088000 "Glazing."

C. Glazing Sealants: Comply with Section 088000 "Glazing."

2.7 ACCESSORIES

A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, non-staining, nonbleeding fasteners and accessories compatible with adjacent materials.
   1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
   2. Reinforce members as required to receive fastener threads.

B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
   1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.

C. Concealed Flashing: Manufacturer's standard corrosion-resistant, non-staining, nonbleeding flashing compatible with adjacent materials.

2.8 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or

grinding.

C. Fabricate components that, when assembled, have the following characteristics:
1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Physical and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Provisions for field replacement of glazing from exterior.
6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Fabricate components to resist water penetration as follows:
1. Internal guttering system or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
2. Pressure-equalized system or double barrier design with primary air and vapor barrier at interior side of glazed aluminum curtain wall and secondary seal weeped and vented to exterior.

E. Curtain-Wall Framing: Fabricate components for assembly using manufacturer's standard assembly method.

F. Factory-Assembled Frame Units:
1. Rigidly secure nonmovement joints.
2. Prepare surfaces that are in contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion.
3. Preparation includes, but is not limited to, cleaning and priming surfaces.
4. Seal joints watertight unless otherwise indicated.
5. Install glazing to comply with requirements in Section 088000 "Glazing."

G. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.9 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

3.3 INSTALLATION

A. General:
   1. Comply with manufacturer's written instructions.
   2. Do not install damaged components.
   3. Fit joints to produce hairline joints free of burrs and distortion.
   4. Rigidly secure nonmovement joints.
   5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
   6. Where welding is required, weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
   7. Seal joints watertight unless otherwise indicated.

B. Metal Protection:
   1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
   2. Where aluminum is in contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.

D. Install components plumb and true in alignment with established lines and grades.

E. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.

F. Install glazing as specified in Section 088000 "Glazing."
   1. Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

G. Install weatherseal sealant according to Section 079200 "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.

3.4 ERECTION TOLERANCES

A. Erection Tolerances: Install glazed aluminum curtain walls to comply with the following maximum tolerances:
   1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.

2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
3. Alignment:
    a. Where surfaces about in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
    b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
    c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.
4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Test Area: Perform tests on [one bay at least 30 feet, by one story] mockups.

C. Field Quality-Control Testing: Perform the following test on mockups.
1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.
    a. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 10, 35, and 70 percent completion.
2. Air Infiltration: ASTM E 783 at 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article but not more than 0.09 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft.
    a. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 10, 35, and 70 percent completion.
3. Water Penetration: ASTM E 1105 at a minimum uniform and cyclic static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft., and shall not evidence water penetration.

D. Glazed aluminum curtain walls will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 084413

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes commercial door hardware for the following:

1. Swinging doors.
2. Sliding doors.
3. Other doors to the extent indicated.

B. Door hardware includes, but is not necessarily limited to, the following:

1. Mechanical door hardware.
2. Electromechanical door hardware.
3. Cylinders specified for doors in other sections.

C. Related Sections:

1. Division 08 Section “Hollow Metal Doors and Frames”.
2. Division 08 Section “Flush Wood Doors”.
3. Division 08 Section “Sound Control Hollow Metal Door Assemblies”.
4. Division 08 Section “Sound Control Wood Door Assemblies”.
5. Division 08 Section “Aluminum-Framed Entrances and Storefronts”.

D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
2. ICC/IBC - International Building Code.
3. NFPA 70 - National Electrical Code.
4. NFPA 80 - Fire Doors and Windows.
5. NFPA 101 - Life Safety Code.
6. NFPA 105 - Installation of Smoke Door Assemblies.
7. State Building Codes, Local Amendments.

E. Standards: All hardware specified herein shall comply with the following industry standards as applicable. Any undated reference to a standard shall be interpreted as referring to the latest edition of that standard:

1. ANSI/BHMA Certified Product Standards - A156 Series.
2. UL10C - Positive Pressure Fire Tests of Door Assemblies.
3. ANSI/UL 294 - Access Control System Units.
4. UL 305 - Panic Hardware.
5. ANSI/UL 437- Key Locks.

1.3 SUBMITTALS

A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.

B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing, fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
3. Content: Include the following information:

    a. Type, style, function, size, label, hand, and finish of each door hardware item.
    b. Manufacturer of each item.
    c. Fastenings and other pertinent information.
    d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
    e. Explanation of abbreviations, symbols, and codes contained in schedule.
    f. Mounting locations for door hardware.
    g. Door and frame sizes and materials.
    h. Warranty information for each product.

4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

C. Shop Drawings: Details of electrified access control hardware indicating the following:

1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:

a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
b. Complete (risers, point-to-point) access control system block wiring diagrams.
c. Wiring instructions for each electronic component scheduled herein.

2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.

D. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.

E. Informational Submittals:

1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.

1.4 CLOSEOUT SUBMITTALS

A. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.

B. Project Record Documents: Provide record documentation of as-built door hardware sets in digital format (.pdf, .docx, .xlsx, .csv) and as required in Division 01, Project Record Documents.

1.5 QUALITY ASSURANCE

A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.

B. Certified Products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).

C. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

D. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to

consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

E. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.

1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.

F. Each unit to bear third party permanent label indicating compliance with the referenced testing standards.

G. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:

1. Function of building, purpose of each area and degree of security required.
2. Plans for existing and future key system expansion.
3. Requirements for key control storage and software.
4. Installation of permanent keys, cylinder cores and software.
5. Address and requirements for delivery of keys.

H. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.

1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
3. Review sequence of operation narratives for each unique access controlled opening.
4. Review and finalize construction schedule and verify availability of materials.
5. Review the required inspecting, testing, commissioning, and demonstration procedures

I. At completion of installation, provide written documentation that components were applied according to manufacturer's instructions and recommendations and according to approved schedule.

1.6 DELIVERY, STORAGE AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.

B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.7 COORDINATION

A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

B. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.8 WARRANTY

A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.
2. Faulty operation of the hardware.
3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
4. Electrical component defects and failures within the systems operation.

C. Warranty Period: Unless otherwise indicated, warranty shall be one year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 BUTT HINGES

A. Hinges: ANSI/BHMA A156.1 butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.

1. Quantity: Provide the following hinge quantity:

a. Two Hinges: For doors with heights up to 60 inches.
b. Three Hinges: For doors with heights 61 to 90 inches.
c. Four Hinges: For doors with heights 91 to 120 inches.
d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.

2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:

a. Widths up to 3’0”: 4-1/2” standard or heavy weight as specified.
b. Sizes from 3’1” to 4’0”: 5” standard or heavy weight as specified.

3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:

a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.

4. Hinge Options: Comply with the following:

a. Non-removable Pins: With the exception of electric through wire hinges, provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for all out-swinging lockable doors.

5. Manufacturers:

a. Hager Companies (HA) - BB Series, 5-knuckle.
b. Ives (IV) - 5BB Series, 5-knuckle.
c. McKinney (MK) - TA/T4A Series, 5-knuckle.
d. dormakaba BEST (ST) - F/FBB Series, 5-knuckle.

2.2 CONTINUOUS HINGES

A. Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 continuous geared hinge. with minimum 0.120-inch thick extruded 6063-T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cut-outs.

1. Manufacturers:.

a. Hager Companies (HA).
b. Ives (IV).
c. Pemko (PE).
d. dormakaba BEST (ST).

2.3 POWER TRANSFER DEVICES

A. Electric Door Wire Harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.

1. Provide one each of the following tools as part of the base bid contract:

a. McKinney (MK) - Electrical Connecting Kit: QC-R001.
b. McKinney (MK) - Connector Hand Tool: QC-R003.

2. Manufacturers:

a. Hager Companies (HA) - Quick Connect.
b. McKinney (MK) - QC-C Series.
c. dormakaba BEST (ST) - WH Series.

2.4 DOOR OPERATING TRIM

A. Flush Bolts and Surface Bolts: Provide products conforming to ANSI/BHMA A156.3 and A156.16, Grade 1.

1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.
2. Furnish dust proof strikes for bottom bolts.
3. Surface bolts to be minimum 8” in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.
4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.
5. Manufacturers:

a. Rockwood (RO).

B. Door Push Plates and Pulls: ANSI/BHMA A156.6 door pushes and pull units of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.

1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.

2. Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.
3. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
4. Pulls, where applicable, shall be provided with a 10” clearance from the finished floor on the push side to accommodate wheelchair accessibility.
5. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets. When through-bolt fasteners are in the same location as a push plate, countersink the fasteners flush with the door face allowing the push plate to sit flat against the door.
6. Manufacturers:

    a. Ives (IV).
    b. Rockwood (RO).
    c. Trimco (TC).

2.5 CYLINDERS AND KEYING

A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.

1. Manufacturers:

    a. dormakaba BEST (BE).
    b. Match Existing, Field Verify.

B. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:

1. Threaded mortise cylinders with rings and cams to suit hardware application.
2. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
3. Bored or cylindrical lock cylinders with tailpieces as required to suit locks.
4. Tubular deadlocks and other auxiliary locks.
5. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
6. Keyway: Match Facility Standard.

C. Keying System: Each type of lock and cylinders to be factory keyed.

1. Supplier shall conduct a "Keying Conference" to define and document keying system instructions and requirements.
2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
3. Existing System: Field verify and key cylinders to match Owner's existing system.

D. Key Quantity: Provide the following minimum number of keys:

1. Change Keys per Cylinder: Two (2)

2. Master Keys (per Master Key Level/Group): Five (5).
3. Construction Keys (where required): Ten (10).

E. Construction Keying: Provide construction master keyed cylinders.

F. Key Registration List (Bitting List):

1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
2. Provide transcript list in writing or electronic file as directed by the Owner.

2.6 KEY CONTROL

A. Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.

1. Manufacturers:

a. Lund Equipment (LU).
b. MMF Industries (MM).
c. Telkee (TK).

2.7 MORTISE LOCKS AND LATCHING DEVICES

A. Mortise Locksets, Grade 1 (Heavy Duty): Provide ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed mortise locksets. Listed manufacturers shall meet all functions and features as specified herein.

1. Provide locksets with functions and features as follows:

a. Heavy duty 12-gauge wrought steel case.
b. Stainless steel 3/4" one-piece anti-friction reversible latchbolt with a one-piece hardened stainless steel 1” projection deadbolt.
c. Where required by code, provide knurling or abrasive coating on all levers leading to hazardous areas.
d. Meets UL and CUL Standard 10C Positive Pressure, Fire Test of Door Assemblies with levers that meet A117.1 Accessibility Code.
e. Meets UL Certification Directory ZHLL.R21744 for products used in windstorm rated assemblies.
f. Extended cycle test: Locks to have been cycle tested in ordinance with ANSI/BHMA 156.13 requirements to 16 million cycles or greater.
g. Status indicators inside, outside, or on both sides of doors as specified; available with wording for “locked/unlocked”, “vacant/occupied” or custom wording options. Indicator to be located above the cylinder with the inside thumb-turn not blocking the visibility of the indicator status.
h. Ten-year limited warranty for mechanical functions.

2. Manufacturers:

    a. dormakaba BEST (BE) - 45H Series.
    b. Sargent Manufacturing (SA) - 8200 Series.
    c. Schlage (SC) - L9000 Series.

2.8 DEADLOCKS AND LATCHES

A. Mortise Deadlocks, Small Case: ANSI/BHMA A156.36, Grade 1, small case mortise type deadlocks constructed of heavy gauge wrought corrosion resistant steel. Steel or stainless steel bolts with a 1" throw and hardened steel roller pins. Deadlocks to be products of the same source manufacturer and keyway as other specified locksets.

1. Manufacturers:

    a. dormakaba BEST (BE) - 48H Series.
    b. Sargent Manufacturing (SA) - 4870 Series.
    c. Schlage (SC) - L460 Series.

2.9 LOCK AND LATCH STRIKES

A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.

B. Standards: Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.
2. Strikes for Bored Locks and Latches: BHMA A156.2.
3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
4. Dustproof Strikes: BHMA A156.16.

2.10 CONVENTIONAL EXIT DEVICES

A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. Exit devices shall have a five-year warranty.
2. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.

3. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer’s catalog and template book for specific requirements.
4. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.
5. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.
6. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.

    a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
    b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.

7. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.
8. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2” wide stiles.
9. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
10. Rail Sizing: Provide exit device rails factory sized for proper door width application.
11. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.

B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed exit devices. Listed manufacturers shall meet all functions and features as specified herein.

1. Provide exit devices with functions and features as follows:

    a. Where required by code, provide knurling or abrasive coating on all levers leading to hazardous areas.
    b. Meets UL and CUL Standard 10C Positive Pressure, Fire Test of Door Assemblies with levers that meet A117.1 Accessibility Code.
    c. Extended cycle test: Exit devices to have been cycle tested in ordinance with ANSI/BHMA 156.3 requirements to 5 million cycles or greater.
    d. Five-year limited warranty for mechanical features.

2. Manufacturers:

    a. Sargent Manufacturing (SA) - 80 Series.
    b. dormakaba BEST (PR) - Apex 2000 Series.
    c. Von Duprin (VD) - 35A/98 XP Series.

2.11 SURFACE DOOR CLOSERS

A. All door closers specified herein shall meet or exceed the following criteria:

1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers.
2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
3. Cycle Testing: Provide closers which have surpassed 15 million cycles.
4. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the Americans with Disabilities Act, provide units complying with ANSI ICC/A117.1.
5. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
6. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
7. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.

B. Door Closers, Surface Mounted (Large Body Cast Iron): ANSI/BHMA A156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control.

1. Large body cast iron surface mounted door closers shall have a 30-year warranty.
2. Manufacturers:

    a. LCN Closers (LC) - 4040XP Series.
    b. Sargent Manufacturing (SA) - 281 Series.
    c. Ryobi (RY) – 4550 Series.

2.12 ARCHITECTURAL TRIM

A. Door Protective Trim

1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1” LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.

3. Where plates are applied to fire rated doors with the top of the plate more than 16” above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer’s catalog and template book for specific requirements for size and applications.
4. Protection Plates: ANSI/BHMA A156.6 protection plates (kick, armor, or mop), fabricated from the following:

    a. Stainless Steel: 300 grade, 050-inch thick.

5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
6. Manufacturers:

    a. Hager Companies (HA).
    b. Ives (IV).
    c. Rockwood (RO).
    d. Trimco (TC).

2.13 DOOR STOPS AND HOLDERS

A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.

B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.

1. Manufacturers:

    a. Hager Companies (HA).
    b. Ives (IV).
    c. Rockwood (RO).
    d. Trimco (TC).

C. Overhead Door Stops and Holders: ANSI/BHMA A156.8, Grade 1 Certified Products Directory (CPD) listed overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.

1. Manufacturers:

    a. dormakaba (DO).
    b. Norton Rixson (RF).
    c. Sargent Manufacturing (SA).

2.14 ARCHITECTURAL SEALS

A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.

B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.

1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.

C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.

1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NFPA 252, Standard Methods of Fire Tests of Door Assemblies.

D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.

E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

F. Manufacturers:

1. National Guard Products (NG).
2. Pemko (PE).
3. Reese Enterprises, Inc. (RE).
4. Zero (ZE).

2.15 ELECTRONIC ACCESSORIES

A. Door Position Switches: Door position magnetic reed contact switches specifically designed for use in commercial door applications. On recessed models the contact and magnetic housing snap-lock into a 1" diameter hole. Surface mounted models include wide gap distance design complete with armored flex cabling. Provide SPDT, N/O switches with optional Rare Earth Magnet installation on steel doors with flush top channels.

1. Manufacturers:

a. Sargent Manufacturing (SA) - 3280 Series.
b. Security Door Controls (SD) - DPS Series.
c. Securitron (SU) - DPS Series.

B. Intelligent Switching Power Supplies: Provide power supplies with single, dual or multi-voltage configurations at 12 and/or 24VDC. Power Supply shall have battery backup function with an integrated battery charging circuit. The power supply shall have a standard, integrated Fire Alarm Interface (FAI). The power supply shall provide capability for secondary voltage, power distribution, direct lock control and network monitoring through add on modules. The power supply shall be expandable up to 16 individually protected outputs. Output modules shall provide individually protected, continuous outputs and/or individually protected, relay controlled outputs. Network modules shall provide remote monitoring functions such as status reporting, fault reporting and information logging.

1. Provide the least number of units, at the appropriate amperage level, sufficient to exceed the required total draw for the specified electrified hardware and access control equipment.
2. Manufacturers:

    a. Securitron (SU) - AQL Series.
    b. Altronix (AS) - Maximal 11F.

2.16 FABRICATION

A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.17 FINISHES

A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware

C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.

B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.

1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.

B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:

1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
2. DHI TDH-007-20: Installation Guide for Doors and Hardware.
3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.

C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

D. Push Plates and Door Pulls: When through-bolt fasteners are in the same location as a push plate, countersink the fasteners flush with the door face allowing the push plate to sit flat against the door.

E. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

F. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.5 CLEANING AND PROTECTION

A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.

B. Clean adjacent surfaces soiled by door hardware installation.

C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.6 DEMONSTRATION

A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.7 DOOR HARDWARE SETS

A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

1. Quantities listed are for each pair of doors, or for each single door.
2. The supplier is responsible for handing and sizing all products.
3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.
4. At existing openings with new hardware the supplier shall field inspect existing conditions prior to the submittal stage to verify the specified hardware will work as required. Provide alternate solutions and proposals as needed.

B. Manufacturer’s Abbreviations:

1. MK - McKinney
2. PE - Pemko
3. RF - Rixson
4. SA - SARGENT
5. RO - Rockwood
6. AT - Accurate Lock and Hardware
7. NO - Norton
8. OT - Other
9. SU - Securitron
10. BE - BEST Locks & Closers

Hardware Sets

Set: 1.0

Doors: 110D

2	Continuous Hinge	CFM_SLF-HD1 SER (Qty of Wires as Required)		PE	⚡
1	Concealed Vert Rod Exit, Nightlatch	LC 53 55 56 AD8610 106 x Less Pull	US32D	SA	⚡
1	Concealed Vert Rod Exit, Exit Only	53 55 56 AD8610 EO	US32D	SA	⚡
2	Door Pull	RM3332-96	US32D	RO	
1	Automatic Opener	D6000 Series (Drop Plate as Required)	689	NO	⚡
1	Gasketing	By Aluminum Door / Frame Supplier			
1	Rain Guard	346C x Width of Frame Head		PE	
2	Sweep	3452APK TKSP		PE	
1	Threshold	273x224AFGT MSES25SS		PE	
2	ElectroLynx Harness	QC-C1500 (Power Supply to Hinge or Device)		MK	⚡
2	ElectroLynx Harness	QC-CXXP (Hinge to Device - Length as Required)		MK	⚡
2	Position Switch	DPS-M - BK		SU	⚡
2	Wall Switch	700 (Motion Sensor Actuator)		NO	⚡
1	Power Supply	AQL4-R8E1		SU	⚡
1	Diagrams	Riser and Wiring Diagrams		OT	
1	Cylinder/Core	Best Keyway - Match Owner Existing System		BE	

Notes:
Operational Narrative:
1. Doors are normally closed and locked.
2. Pressing one of the wall switches will momentarily retract the latchbolts and trigger the automatic operator to open the doors.
3. Entry by mechanical key override. Free egress at all times.
4. Request to exit switches shunt alarm upon exiting. Door position switches report position of doors to access control system. Latchbolt monitor reports position of latchbolts to access control system.
5. Devices are fail secure, upon power failure the doors will remain locked.
6. Doors can be placed on a lock / unlock time schedule as dictated by the access control system.

Set: 2.0

Doors: 110B

2	Continuous Hinge	CFM_SLF-HD1 SER (Qty of Wires as Required)		PE	⚡
1	Concealed Vert Rod Exit, Nightlatch	LC 53 55 56 AD8610 106 x Less Pull	US32D	SA	⚡
1	Concealed Vert Rod Exit, Exit Only	53 55 56 AD8610 EO	US32D	SA	⚡
2	Door Pull	RM3332-96	US32D	RO	
1	Automatic Opener	D6000 Series (Drop Plate as Required)	689	NO	⚡
1	Gasketing	By Aluminum Door / Frame Supplier			
2	ElectroLynx Harness	QC-C1500 (Power Supply to Hinge or Device)		MK	⚡
2	ElectroLynx Harness	QC-CXXP (Hinge to Device - Length as Required)		MK	⚡
2	Position Switch	DPS-M - BK		SU	⚡
2	Wall Switch	700 (Motion Sensor Actuator)		NO	⚡
1	Power Supply	AQL4-R8E1		SU	⚡
1	Diagrams	Riser and Wiring Diagrams		OT	
1	Cylinder/Core	Best Keyway - Match Owner Existing System		BE	

Notes:
Operational Narrative:
1. Doors are normally closed and locked.
2. Pressing one of the wall switches will momentarily retract the latchbolts and trigger the automatic operator to open the doors.
3. Entry by mechanical key override. Free egress at all times.
4. Request to exit switches shunt alarm upon exiting. Door position switches report position of doors to access control system. Latchbolt monitor reports position of latchbolts to access control system.
5. Devices are fail secure, upon power failure the doors will remain locked.
6. Doors can be placed on a lock / unlock time schedule as dictated by the access control system.

Set: 3.0

Doors: 320B, 322

2	Continuous Hinge	CFM_SLF-HD1 SER (Qty of Wires as Required)		PE	⚡
1	Concealed Vert Rod Exit, Nightlatch	LC 53 55 56 AD8610 106 x Less Pull	US32D	SA	⚡
1	Concealed Vert Rod Exit, Exit Only	53 55 AD8610 EO	US32D	SA	⚡
2	Surface Closer	281 CPS	EN	SA	
2	Door Pull	RM3332-96	US32D	RO	
1	Gasketing	By Aluminum Door / Frame Supplier			

2	ElectroLynx Harness	QC-C1500 (Power Supply to Hinge or Device)		MK ⚡
2	ElectroLynx Harness	QC-CXXP (Hinge to Device - Length as Required)		MK ⚡
1	Card Reader	Provided By Security Supplier		OT
2	Position Switch	DPS-M - BK		SU ⚡
1	Power Supply	AQL4-R8E1		SU ⚡
1	Diagrams	Riser and Wiring Diagrams		OT
1	Cylinder/Core	Best Keyway - Match Owner Existing System		BE

Notes:
Operational Narrative:
1. Doors are normally closed and locked.
2. Presenting a valid credential to the reader will momentarily retract the latchbolt allowing entry.
3. Entry by mechanical key override. Free egress at all times.
4. Request to exit switches shunt alarm upon exiting. Door position switches report position of doors to access control system. Latchbolt monitor reports position of latchbolts to access control system.
5. Devices are fail secure, upon power failure the doors will remain locked.
6. Doors can be placed on a lock / unlock time schedule as dictated by the access control system.

Set: 4.0

Doors: 110C

2	Continuous Hinge	CFM_SLF-HD1 x Length Required		PE
1	Concealed Vert Rod Exit, Nightlatch	LC AD8610 106 x Less Pull	US32D	SA
1	Concealed Vert Rod Exit, Exit Only	AD8610 EO	US32D	SA
2	Surface Closer	281 CPS	EN	SA
2	Door Pull	RM3332-96	US32D	RO
1	Gasketing	Provided By Door/Frame Supplier		OT
1	Rain Guard	346C x Width of Frame Head		PE
2	Sweep	345AV x Length Required		PE
1	Threshold	171A x Length Required x MSES25SS		PE
2	Position Switch	DPS - M / W-BK (SPDT)		SU ⚡
1	Cylinder/Core	Best Keyway - Match Owner Existing System		BE

Set: 5.0

Doors: 110A

2	Continuous Hinge	CFM_SLF-HD1 x Length Required		PE

1	Concealed Vert Rod Exit, Nightlatch	LC AD8610 106 x Less Pull	US32D	SA	
1	Concealed Vert Rod Exit, Exit Only	AD8610 EO	US32D	SA	
2	Surface Closer	281 PS	EN	SA	
2	Door Pull	RM3332-96	US32D	RO	
1	Gasketing	Provided By Door/Frame Supplier		OT	
1	Cylinder/Core	Best Keyway - Match Owner Existing System		BE	

Set: 6.0

Doors: E107

3	Hinge (heavy weight)	T4A3386	US32D	MK	
1	Rim Exit Device, Storeroom	LC 8804 ETNJ	US32D	SA	
1	Surface Closer	281 CPS	EN	SA	
1	Kick Plate	K1050 10" high CSK BEV	US32D	RO	
1	Gasketing	303AS (Head & Jambs)		PE	
1	Rain Guard	346C x Width of Frame Head		PE	
1	Sweep	345AV x Length Required		PE	
1	Threshold	171A x Length Required x MSES25SS		PE	
1	Position Switch	DPS - M / W-BK (SPDT)		SU	⚡
1	Cylinder/Core	Best Keyway - Match Owner Existing System		BE	

Set: 7.0

Doors: T101

3	Hinge, Full Mortise	TA2314	US32D	MK	
1	Storeroom Lock	LC 8204 LNJ	US32D	SA	
1	Surface Closer	281 CPS	EN	SA	
1	Kick Plate	K1050 10" high CSK BEV	US32D	RO	
1	Gasketing	303AS (Head & Jambs)		PE	
1	Rain Guard	346C x Width of Frame Head		PE	
1	Sweep	345AV x Length Required		PE	
1	Threshold	171A x Length Required x MSES25SS		PE	
1	Position Switch	DPS - M / W-BK (SPDT)		SU	⚡
1	Cylinder/Core	Best Keyway - Match Owner Existing System		BE	

Set: 8.0

Doors: 347

8	Hinge, Full Mortise	TA2314	US32D	MK
1	Storeroom Lock	LC 8204 LNJ	US32D	SA
1	Dust Proof Strike	570	US26D	RO
1	Flush Bolt	2842 / 2962 (As Required)	US32D	RO
2	Surface Closer	281 CPS	EN	SA
2	Kick Plate	K1050 10" high CSK BEV	US32D	RO
1	Astragal	29310CS x Door Height		PE
1	Gasketing	303AS (Head & Jambs)		PE
1	Rain Guard	346C x Width of Frame Head		PE
2	Sweep	345AV x Length Required		PE
1	Threshold	171A x Length Required x MSES25SS		PE
2	Position Switch	DPS - M / W-BK (SPDT)		SU ⚡
1	Cylinder/Core	Best Keyway - Match Owner Existing System		BE

Set: 9.0

Doors: T102, T103

3	Hinge, Full Mortise	TA2314	US32D	MK
1	Classroom Deadlock	LB LC 4877	US26D	SA
1	Surface Closer	281 UO	EN	SA
2	Door Pull	RM3320-72	US32D	RO
1	Kick Plate	K1050 10" high CSK BEV	US32D	RO
1	Gasketing	303AS (Head & Jambs)		PE
1	Rain Guard	346C x Width of Frame Head		PE
1	Sweep	345AV x Length Required		PE
1	Threshold	171A x Length Required x MSES25SS		PE
1	Position Switch	DPS - M / W-BK (SPDT)		SU ⚡
1	Cylinder/Core	Best Keyway - Match Owner Existing System		BE

Set: 10.0

Doors: 104A

2	Continuous Hinge	CFM_SLF-HD1 x Length Required		PE

1	Concealed Vert Rod Exit, Exit Only	AD8610 EO	US32D	SA
1	Concealed Vert Rod Exit	LC AD8606 ETNJ	US32D	SA
2	Surface Closer	281 PS	EN	SA
1	Gasketing	Provided By Door/Frame Supplier		OT
1	Cylinder/Core	Best Keyway - Match Owner Existing System		BE

Notes: STC 51 OPENING. HARDWARE IS LISTED AS BASIS OF DESIGN. DOOR MANUFACTURER TO PROVIDE ASSEMBLY REQUIREMENTS TO MEET RATING.

Set: 11.0

Doors: 107

3	Hinge (heavy weight)	T4A3786	US26D	MK
1	Rim Exit Device, Storeroom	LC 8804 ETNJ	US32D	SA
1	Surface Closer	281 PS	EN	SA
1	Kick Plate	K1050 10" high CSK BEV	US32D	RO
3	Silencer	608		RO
1	Cylinder/Core	Best Keyway - Match Owner Existing System		BE

Set: 12.0

6	Hinge (heavy weight)	T4A3786	US26D	MK
1	Surface Vert Rod Exit, Exit Only	NB8710 EO	US32D	SA
1	Surface Vert Rod Exit, Classroom	LC NB8713 ETNJ	US32D	SA
2	Surface Closer	281 PS	EN	SA
2	Kick Plate	K1050 10" high CSK BEV	US32D	RO
1	Astragal	29310CS x Door Height		PE
2	Silencer	608		RO
1	Cylinder/Core	Best Keyway - Match Owner Existing System		BE

Set: 13.0

Doors: 104B, 105B

3	Hinge (heavy weight)	T4A3786	US26D	MK
1	Rim Exit Device, Classroom	LC 8813 ETNJ	US32D	SA
1	Surface Closer	281 PS	EN	SA
1	Kick Plate	K1050 10" high CSK BEV	US32D	RO
3	Silencer	608		RO

1	Cylinder/Core	Best Keyway - Match Owner Existing System		BE

Set: 14.0

Doors: 259A, 259C

2	Hinge, Full Mortise	TA2714	US26D	MK
1	Hinge, Full Mortise	TA2714 QC_	US26D	MK
1	Fail Secure Lock	LC 8271-_V LNJ	US26D	SA ⚡
1	Surface Closer	281 PS	EN	SA
1	Kick Plate	K1050 10" high CSK BEV	US32D	RO
1	Gasketing	S88BL (Head & Jambs)		PE
1	Card Reader	Provided By Security Supplier		OT
1	ElectroLynx Harness	QC-C**** x Length Required		MK ⚡
1	ElectroLynx Harness	QC-C1500P		MK ⚡
1	Position Switch	DPS - M / W-BK (SPDT)		SU ⚡
1	Power Supply	AQL-R (Size and Type required)		SU ⚡
1	Wiring Diagram	Elevation and Point to Point as Specified		OT
1	Cylinder/Core	Best Keyway - Match Owner Existing System		BE

Notes: Operational Narrative:
1. Doors normally closed and secure.
2. Authorized access by card reader allowing ingress.
3. Door position switch monitor open/closed status.
4. Lockset remains locked (fail secure) in event of power loss. Keyed cylinder override for emergency access.

Set: 15.0

3	Hinge, Full Mortise	TA2714	US26D	MK
1	Storeroom Lock	LC 8204 LNJ	US26D	SA
1	Wall Stop	403 (or) 441CU (As Required)	US26D	RO
3	Silencer	608		RO
1	Cylinder/Core	Best Keyway - Match Owner Existing System		BE

Set: 16.0

3	Hinge, Full Mortise	TA2714	US26D	MK

1	Storeroom Lock	LC 8204 LNJ	US26D	SA
1	Surface Closer	281 UO	EN	SA
1	Kick Plate	K1050 10" high CSK BEV	US32D	RO
1	Wall Stop	403 (or) 441CU (As Required)	US26D	RO
3	Silencer	608		RO
1	Cylinder/Core	Best Keyway - Match Owner Existing System		BE

Set: 17.0

Doors: 104C, 322E

3	Hinge, Full Mortise	TA2714	US26D	MK
1	Storeroom Lock	LC 8204 LNJ	US26D	SA
1	Surface Closer	281 PS	EN	SA
1	Kick Plate	K1050 10" high CSK BEV	US32D	RO
3	Silencer	608		RO
1	Cylinder/Core	Best Keyway - Match Owner Existing System		BE

Set: 18.0

Doors: 260A

4	Hinge, Full Mortise	TA2714	US26D	MK
1	Storeroom Lock	LC 8204 LNJ	US26D	SA
1	Surface Closer	281 UO	EN	SA
1	Kick Plate	K1050 10" high CSK BEV	US32D	RO
1	Wall Stop	403 (or) 441CU (As Required)	US26D	RO
1	Gasketing	S88BL (Head & Jambs)		PE
1	Cylinder/Core	Best Keyway - Match Owner Existing System		BE

Set: 19.0

Doors: 258A

7	Hinge, Full Mortise	TA2714	US26D	MK
1	Hinge, Full Mortise	TA2714 QC_	US26D	MK
1	Fail Secure Lock	LC 8271-_V LNJ	US26D	SA ⚡
1	Dust Proof Strike	570	US26D	RO
1	Flush Bolt	2842 / 2962 (As Required)	US32D	RO
2	Surface Closer	281 PS	EN	SA

2	Kick Plate	K1050 10" high CSK BEV	US32D	RO
1	Astragal	29310CS x Door Height		PE
2	Silencer	608		RO
1	ElectroLynx Harness	QC-C1500 (Power Supply to Hinge or Device)		MK ⚡
1	ElectroLynx Harness	QC-C**** x Length Required		MK ⚡
2	Position Switch	DPS - M / W-BK (SPDT)		SU ⚡
1	Power Supply	AQL-R (Size and Type required)		SU ⚡
1	Wiring Diagram	Elevation and Point to Point as Specified		OT
1	Cylinder/Core	Best Keyway - Match Owner Existing System		BE

Notes: Notes: Operational Narrative:
1. Doors normally closed and secure.
2. Authorized access by card reader allowing ingress.
3. Door position switch monitor open/closed status.
4. Lockset remains locked (fail secure) in event of power loss. Keyed cylinder override for emergency access.

Set: 20.0

Doors: 258E

6	Hinge (heavy weight)	T4A3786	US26D	MK
2	Hinge, Full Mortise, Hvy Wt	T4A3786 QC_	US26D	MK
1	Concealed Vert Rod Exit, Exit Only	12 TB 53 55 MD8610 EO	US32D	SA ⚡
1	Mortise Exit Device, Storeroom	12 LC TB 53 55 56 8904 ETNJ	US32D	SA ⚡
2	Surface Closer	281 CPS	EN	SA
2	Kick Plate	K1050 10" high CSK BEV	US32D	RO
1	Astragal	29310CS x Door Height		PE
1	Gasketing	S88BL (Head & Jambs)		PE
1	Card Reader	Provided By Security Supplier		OT
2	ElectroLynx Harness	QC-C**** x Length Required		MK ⚡
2	ElectroLynx Harness	QC-C1500P		MK ⚡
2	Position Switch	DPS - M / W-BK (SPDT)		SU ⚡
1	Power Supply	AQL-R (Size and Type required)		SU ⚡
1	Wiring Diagram	Elevation and Point to Point as Specified		OT
1	Diagrams	Riser and Wiring Diagrams		OT
2	Explosion-Resistant Enclosure	Killark UL1203		OT

1	Cylinder/Core	Best Keyway - Match Owner Existing System	BE

Notes: AHJ to confirm H2 compliance.

The above hardware is illustrated as a basis of design. If alternate hardware is required to meet class 1 division 1, provide architect with information.

Operational Narrative:
1. Door normally closed and secure.
2. Authorized access by card reader retracting latch for a predetermined time limit. Latch can remain unlocked for open access.
3. Egress free for immediate exit.
4. Latchbolt monitor signlas latchbolt position.
5. REX switch in push rail allows authorized exit without alarm condition.
6. Door position switch monitors open/closed/latched status.
7. Exit Device remains locked (fail secure) in event of power loss. Keyed cylinder override for emergency access.

Set: 21.0

Doors: 258C

2	Intermediate Pivot	ML19	626	RF
2	Pivot Set	L147	626	RF
1	Passage Latch	74 8215 LNJ	US26D	SA
1	Constant Latching Top Bolt Only	2905	US26D	RO
2	Surface Closer	281 PS Lead Line Cover	EN	SA
2	Kick Plate	K1050 10" high CSK BEV	US32D	RO
1	Gasketing	S88BL (Head & Jambs)		PE
1	Occupancy / In-Use Light	Occupancy / In-Use Light by Others		OT

Set: 22.0

Doors: 264

8	Hinge, Full Mortise	TA2714	US26D	MK
1	Classroom Lock	LC 8237 LNJ	US26D	SA
1	Dust Proof Strike	570	US26D	RO
1	Flush Bolt	2842 / 2962 (As Required)	US32D	RO
2	Surface Closer	281 PS	EN	SA
2	Kick Plate	K1050 10" high CSK BEV	US32D	RO
1	Astragal	29310CS x Door Height		PE
2	Silencer	608		RO

1	Cylinder/Core	Best Keyway - Match Owner Existing System		BE

Notes: Notes: Operational Narrative:
1. Doors normally closed and secure.
2. Authorized access by card reader allowing ingress.
3. Door position switch monitor open/closed status.
4. Lockset remains locked (fail secure) in event of power loss. Keyed cylinder override for emergency access.

Set: 23.0

Doors: 112, 258H

6	Hinge, Full Mortise	TA2714	US26D	MK
1	Storeroom Lock	LC 8204 LNJ	US26D	SA
1	Dust Proof Strike	570	US26D	RO
1	Flush Bolt	555 / 557 (As Required)	US26D	RO
2	Surface Closer	281 PS	EN	SA
2	Surf Overhead Stop	9 Series	630	RF
2	Kick Plate	K1050 10" high CSK BEV	US32D	RO
1	Astragal	29310CS x Door Height		PE
2	Silencer	608		RO
1	Cylinder/Core	Best Keyway - Match Owner Existing System		BE

Set: 24.0

Doors: 120, 258F, 258G, 302, 322C

3	Hinge, Full Mortise	TA2714	US26D	MK
1	Office Lock	LB LC 8205 LNJ	US26D	SA
1	Wall Stop	403 (or) 441CU (As Required)	US26D	RO
3	Silencer	608		RO
1	Cylinder/Core	Best Keyway - Match Owner Existing System		BE

Set: 25.0

Doors: 259B, 259D, 303

3	Hinge, Full Mortise	TA2714	US26D	MK
1	Classroom Lock	LC 8237 LNJ	US26D	SA
1	Wall Stop	403 (or) 441CU (As Required)	US26D	RO

3	Silencer	608		RO
1	Cylinder/Core	Best Keyway - Match Owner Existing System		BE

Set: 26.0

Doors: 106A

3	Hinge, Full Mortise	TA2714	US26D	MK
1	Classroom Lock	LC 8237 LNJ	US26D	SA
1	Surface Closer	281 UO	EN	SA
1	Surf Overhead Stop	9 Series	630	RF
1	Kick Plate	K1050 10" high CSK BEV	US32D	RO
3	Silencer	608		RO
1	Cylinder/Core	Best Keyway - Match Owner Existing System		BE

Set: 27.0

Doors: 258B

3	Hinge, Full Mortise	TA2714	US26D	MK
1	Classroom Lock	LC 8237 LNJ	US26D	SA
1	Surface Closer	281 UO	EN	SA
1	Kick Plate	K1050 10" high CSK BEV	US32D	RO
1	Wall Stop	403 (or) 441CU (As Required)	US26D	RO
1	Gasketing	S88BL (Head & Jambs)		PE
1	Cylinder/Core	Best Keyway - Match Owner Existing System		BE

Set: 28.0

Doors: 258D

6	Hinge, Full Mortise	TA2714	US26D	MK
1	Classroom Lock	LC 8237 LNJ	US26D	SA
1	Dust Proof Strike	570	US26D	RO
1	Flush Bolt	555 / 557 (As Required)	US26D	RO
1	Surface Closer	281 PS	EN	SA
1	Surf Overhead Stop	9 Series	630	RF
2	Kick Plate	K1050 10" high CSK BEV	US32D	RO
1	Astragal	29310CS x Door Height		PE
2	Silencer	608		RO

1	Cylinder/Core	Best Keyway - Match Owner Existing System		BE

Set: 29.0

Doors: 111, 113

3	Hinge, Full Mortise	TA2714	US26D	MK
1	Privacy Lock	LB V21 8265 LNJ	US26D	SA
1	Surface Closer	281 UO	EN	SA
1	Kick Plate	K1050 10" high CSK BEV	US32D	RO
1	Wall Stop	403 (or) 441CU (As Required)	US26D	RO
1	Gasketing	S88BL (Head & Jambs)		PE

Set: 30.0

Doors: 322A, 322B

4	Hinge, Full Mortise	TA2714	US26D	MK
1	Passage Latch	8215 LNJ	US26D	SA
1	Surf Overhead Stop	9 Series	630	RF
3	Silencer	608		RO

Set: 31.0

Doors: 115, 116

3	Hinge, Full Mortise	TA2714	US26D	MK
1	Classroom Deadlock	LB LC 4877	US26D	SA
1	Surface Closer	281 UO	EN	SA
2	Door Pull	RM3320-72	US32D	RO
1	Kick Plate	K1050 10" high CSK BEV	US32D	RO
1	Wall Stop	403 (or) 441CU (As Required)	US26D	RO
1	Cylinder/Core	Best Keyway - Match Owner Existing System		BE

Set: 32.0

Doors: 258J

1	Track	H1100A-OH x Length Required		PE
1	Sliding Door Entry Lockset	Accurate SL9100ADA	US32D	AT
1	Cylinder/Core	Best Keyway - Match Owner Existing System		BE

Set: 33.0

Doors: 105A, 260B

1 All Hardware	By Door Manufacturer	OT

END OF SECTION 087100

B. Manufacturer's Abbreviations:

1. MK - McKinney
2. PE - Pemko
3. RO - Rockwood
4. SA - SARGENT
5. AT - Accurate Lock and Hardware
6. RF - Rixson
7. OT - Other
8. SU - Securitron
9. BE - BEST Locks & Closers

Set: 6.1
Doors: 151

3	Hinge, Full Mortise	TA2314	US32D	MK
1	Storeroom Lock	LC 8204 LNJ	US32D	SA
1	Surface Closer	281 CPS	EN	SA
1	Kick Plate	K1050 10" high CSK BEV	US32D	RO
1	Gasketing	303AS (Head & Jambs)		PE
1	Rain Guard	346C x Width of Frame Head		PE
1	Sweep	345AV x Length Required		PE
1	Threshold	1715A x Length Required x MSES25SS		PE
1	Position Switch	DPS - M / W-BK (SPDT)		SU
1	Cylinder/Core	Best Keyway - Match Owner Existing System		BE

Set: 7.1
Doors: 152A, 152B

6	Hinge, Full Mortise	TA2314	US32D	MK
1	Dust Proof Strike	570	US26D	RO
1	Flush Bolt	2842 / 2962 (As Required)	US32D	RO
1	Classroom Lock	LC 8237 LNJ	US32D	SA
1	Coordinator	2672 x Mtg Brkts	US28	RO
2	Surface Closer	281 CPS	EN	SA
2	Kick Plate	K1050 10" high CSK BEV	US32D	RO
1	Astragal	29310CS x Door Height		PE
1	Gasketing	303AS (Head & Jambs)		PE
1	Rain Guard	346C x Width of Frame Head		PE
2	Sweep	345AV x Length Required		PE
1	Threshold	1715A x Length Required x MSES25SS		PE
2	Position Switch	DPS - M / W-BK (SPDT)		SU
1	Cylinder/Core	Best Keyway - Match Owner Existing System		BE

END OF SECTION 08 71 00

SECTION 087100.02 - DOOR HARDWARE (PAVILLION)

PART 1 GENERAL

1.01REFERENCE STANDARDS

A. BHMA A156.1 - Standard for Butts and Hinges; 2021.

B. BHMA A156.3 - Exit Devices; 2020.

C. BHMA A156.4 - Door Controls - Closers; 2019.

D. BHMA A156.6 - Standard for Architectural Door Trim; 2021.

E. BHMA A156.8 - Door Controls - Overhead Stops and Holders; 2021.

F. BHMA A156.13 - Mortise Locks & Latches Series 1000; 2022.

G. BHMA A156.16 - Auxiliary Hardware; 2018.

H. BHMA A156.18 - Materials and Finishes; 2020.

I. BHMA A156.26 - Standard for Continuous Hinges; 2021.

J. BHMA A156.36 - Auxiliary Locks; 2020.

K. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

L. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2022.

M. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

N. NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives; 2022.

O. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; 2022.

P. UL 294 - Access Control System Units; Current Edition, Including All Revisions.

Q. UL 305 - Standard for Panic Hardware; Current Edition, Including All Revisions.

R. UL 437 - Standard for Key Locks; Current Edition, Including All Revisions.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.03 SUMMARY

A. This Section includes commercial door hardware for the following:

1. Swinging doors.

2. Sliding doors.

3. Other doors to the extent indicated.

B. Door hardware includes, but is not necessarily limited to, the following:

1. Mechanical door hardware.

2. Electromechanical door hardware.

3. Cylinders specified for doors in other sections.

C. Related Sections:

1. Division 08 Section “Hollow Metal Doors and Frames”.

2. Division 08 Section “Flush Wood Doors”.

3. Division 08 Section “Sound Control Hollow Metal Door Assemblies”.

4. Division 08 Section “Sound Control Wood Door Assemblies”.

5. Division 08 Section “Aluminum-Framed Entrances and Storefronts”.

D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.

2. ICC/IBC - International Building Code.

3. NFPA 70 - National Electrical Code.

4. NFPA 80 - Fire Doors and Windows.

5. NFPA 101 - Life Safety Code.

6. NFPA 105 - Installation of Smoke Door Assemblies.

7. State Building Codes, Local Amendments.

E. Standards: All hardware specified herein shall comply with the following industry standards as applicable. Any undated reference to a standard shall be interpreted as referring to the latest edition of that standard:

1. ANSI/BHMA Certified Product Standards - A156 Series.
2. UL10C - Positive Pressure Fire Tests of Door Assemblies.
3. ANSI/UL 294 - Access Control System Units.
4. UL 305 - Panic Hardware.
5. ANSI/UL 437- Key Locks.

1.04 SUBMITTALS

A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.

B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing, fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
3. Content: Include the following information:
    a. Type, style, function, size, label, hand, and finish of each door hardware item.
    b. Manufacturer of each item.
    c. Fastenings and other pertinent information.
    d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
    e. Explanation of abbreviations, symbols, and codes contained in schedule.
    f. Mounting locations for door hardware.
    g. Door and frame sizes and materials.
    h. Warranty information for each product.

4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

C. Shop Drawings: Details of electrified access control hardware indicating the following:

1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:

a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.

b. Complete (risers, point-to-point) access control system block wiring diagrams.

c. Wiring instructions for each electronic component scheduled herein.

2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.

D. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.

E. Informational Submittals:

1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.

1.05 CLOSEOUT SUBMITTALS

A. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.

B. Project Record Documents: Provide record documentation of as-built door hardware sets in digital format (.pdf, .docx, .xlsx, .csv) and as required in Division 01, Project Record Documents.

1.06 QUALITY ASSURANCE

A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.

B. Certified Products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).

C. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

D. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

E. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.

   1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.

   2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.

F. Each unit to bear third party permanent label indicating compliance with the referenced testing standards.

G. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:

   1. Function of building, purpose of each area and degree of security required.

   2. Plans for existing and future key system expansion.

   3. Requirements for key control storage and software.

   4. Installation of permanent keys, cylinder cores and software.

5. Address and requirements for delivery of keys.

H. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.

1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.

2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.

3. Review sequence of operation narratives for each unique access controlled opening.

4. Review and finalize construction schedule and verify availability of materials.

5. Review the required inspecting, testing, commissioning, and demonstration procedures

I. At completion of installation, provide written documentation that components were applied according to manufacturer's instructions and recommendations and according to approved schedule.

1.07 DELIVERY, STORAGE AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.

B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.08 COORDINATION

A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

B. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.09 WARRANTY

A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.

2. Faulty operation of the hardware.

3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

4. Electrical component defects and failures within the systems operation.

C. Warranty Period: Unless otherwise indicated, warranty shall be one year from date of Substantial Completion.

PART 2 PRODUCTS

2.01 BUTT HINGES

A. Hinges: ANSI/BHMA A156.1 butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.

1. Quantity: Provide the following hinge quantity:

a. Two Hinges: For doors with heights up to 60 inches.

b. Three Hinges: For doors with heights 61 to 90 inches.

c. Four Hinges: For doors with heights 91 to 120 inches.

d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.

2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:

a. Widths up to 3’0”: 4-1/2” standard or heavy weight as specified.

b. Sizes from 3’1” to 4’0”: 5” standard or heavy weight as specified.

3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:

a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.

b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.

4. Hinge Options: Comply with the following:

a. Non-removable Pins: With the exception of electric through wire hinges, provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for all out-swinging lockable doors.

5. Manufacturers:

a. Hager Companies (HA) - BB Series, 5-knuckle.

b. Ives (IV) - 5BB Series, 5-knuckle.

c. McKinney (MK) - TA/T4A Series, 5-knuckle.

d. dormakaba BEST (ST) - F/FBB Series, 5-knuckle.

2.02 CONTINUOUS HINGES

A. Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 continuous geared hinge. with minimum 0.120-inch thick extruded 6063-T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cut-outs.

1. Manufacturers:.

a. Hager Companies (HA).

b. Ives (IV).

c. Pemko (PE).

d. dormakaba BEST (ST).

2.03 POWER TRANSFER DEVICES

A. Electric Door Wire Harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.

1. Provide one each of the following tools as part of the base bid contract:

   a. McKinney (MK) - Electrical Connecting Kit: QC-R001.

   b. McKinney (MK) - Connector Hand Tool: QC-R003.

2. Manufacturers:

   a. Hager Companies (HA) - Quick Connect.

   b. McKinney (MK) - QC-C Series.

   c. dormakaba BEST (ST) - WH Series.

2.04 DOOR OPERATING TRIM

A. Flush Bolts and Surface Bolts: Provide products conforming to ANSI/BHMA A156.3 and A156.16, Grade 1.

1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.

2. Furnish dust proof strikes for bottom bolts.

3. Surface bolts to be minimum 8” in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.

4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.

5. Manufacturers:

   a. Rockwood (RO).

B. Door Push Plates and Pulls: ANSI/BHMA A156.6 door pushes and pull units of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.

1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.

2. Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.

3. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.

4. Pulls, where applicable, shall be provided with a 10” clearance from the finished floor on the push side to accommodate wheelchair accessibility.

5. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets. When through-bolt fasteners are in the same location as a push plate, countersink the fasteners flush with the door face allowing the push plate to sit flat against the door.

6. Manufacturers:

   a. Ives (IV).

   b. Rockwood (RO).

   c. Trimco (TC).

2.05 CYLINDERS AND KEYING

A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.

   1. Manufacturers:

      a. dormakaba BEST (BE).

      b. Match Existing, Field Verify.

B. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:

   1. Threaded mortise cylinders with rings and cams to suit hardware application.

   2. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.

   3. Bored or cylindrical lock cylinders with tailpieces as required to suit locks.

   4. Tubular deadlocks and other auxiliary locks.

5. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.

6. Keyway: Match Facility Standard.

C. Keying System: Each type of lock and cylinders to be factory keyed.

1. Supplier shall conduct a "Keying Conference" to define and document keying system instructions and requirements.

2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.

3. Existing System: Field verify and key cylinders to match Owner's existing system.

D. Key Quantity: Provide the following minimum number of keys:

1. Change Keys per Cylinder: Two (2)

2. Master Keys (per Master Key Level/Group): Five (5).

3. Construction Keys (where required): Ten (10).

E. Construction Keying: Provide construction master keyed cylinders.

F. Key Registration List (Bitting List):

1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.

2. Provide transcript list in writing or electronic file as directed by the Owner.

2.06 KEY CONTROL

A. Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.

1. Manufacturers:

a. Lund Equipment (LU).

b. MMF Industries (MM).

c. Telkee (TK).

2.07 MORTISE LOCKS AND LATCHING DEVICES

A. Mortise Locksets, Grade 1 (Heavy Duty): Provide ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed mortise locksets. Listed manufacturers shall meet all functions and features as specified herein.

1. Provide locksets with functions and features as follows:

a. Heavy duty 12-gauge wrought steel case.

b. Stainless steel 3/4" one-piece anti-friction reversible latchbolt with a one-piece hardened stainless steel 1” projection deadbolt.

c. Where required by code, provide knurling or abrasive coating on all levers leading to hazardous areas.

d. Meets UL and CUL Standard 10C Positive Pressure, Fire Test of Door Assemblies with levers that meet A117.1 Accessibility Code.

e. Meets UL Certification Directory ZHLL.R21744 for products used in windstorm rated assemblies.

f. Extended cycle test: Locks to have been cycle tested in ordinance with ANSI/BHMA 156.13 requirements to 16 million cycles or greater.

g. Status indicators inside, outside, or on both sides of doors as specified; available with wording for “locked/unlocked”, “vacant/occupied” or custom wording options. Indicator to be located above the cylinder with the inside thumb-turn not blocking the visibility of the indicator status.

h. Ten-year limited warranty for mechanical functions.

2. Manufacturers:

a. dormakaba BEST (BE) - 45H Series.

b. Sargent Manufacturing (SA) - 8200 Series.

c. Schlage (SC) - L9000 Series.

2.08 DEADLOCKS AND LATCHES

A. Mortise Deadlocks, Small Case: ANSI/BHMA A156.36, Grade 1, small case mortise type deadlocks constructed of heavy gauge wrought corrosion resistant steel. Steel or stainless steel bolts with a 1" throw and hardened steel roller pins. Deadlocks to be products of the same source manufacturer and keyway as other specified locksets.

1. Manufacturers:

a. dormakaba BEST (BE) - 48H Series.

b. Sargent Manufacturing (SA) - 4870 Series.

c. Schlage (SC) - L460 Series.

2.09 LOCK AND LATCH STRIKES

A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.

2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.

3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.

4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.

B. Standards: Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.

2. Strikes for Bored Locks and Latches: BHMA A156.2.

3. Strikes for Auxiliary Deadlocks: BHMA A156.36.

4. Dustproof Strikes: BHMA A156.16.

2.10 CONVENTIONAL EXIT DEVICES

A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. Exit devices shall have a five-year warranty.

2. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.

3. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer’s catalog and template book for specific requirements.

4. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.

5. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.

6. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.

    a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.

    b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.

7. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.

8. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2” wide stiles.

9. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.

10. Rail Sizing: Provide exit device rails factory sized for proper door width application.

11. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.

B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed exit devices. Listed manufacturers shall meet all functions and features as specified herein.

    1. Provide exit devices with functions and features as follows:

        a. Where required by code, provide knurling or abrasive coating on all levers leading to hazardous areas.

        b. Meets UL and CUL Standard 10C Positive Pressure, Fire Test of Door Assemblies with levers that meet A117.1 Accessibility Code.

c. Extended cycle test: Exit devices to have been cycle tested in ordinance with ANSI/BHMA 156.3 requirements to 5 million cycles or greater.

d. Five-year limited warranty for mechanical features.

2. Manufacturers:

a. Sargent Manufacturing (SA) - 80 Series.

b. dormakaba BEST (PR) - Apex 2000 Series.

c. Von Duprin (VD) - 35A/98 XP Series.

2.11 SURFACE DOOR CLOSERS

A. All door closers specified herein shall meet or exceed the following criteria:

1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers.

2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.

3. Cycle Testing: Provide closers which have surpassed 15 million cycles.

4. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the Americans with Disabilities Act, provide units complying with ANSI ICC/A117.1.

5. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.

6. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.

7. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.

B. Door Closers, Surface Mounted (Large Body Cast Iron): ANSI/BHMA A156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control.

1. Large body cast iron surface mounted door closers shall have a 30-year warranty.

2. Manufacturers:

   a. LCN Closers (LC) - 4040XP Series.

   b. Sargent Manufacturing (SA) - 281 Series.

   c. Ryobi (RY) – 4550 Series.

2.12 ARCHITECTURAL TRIM

A. Door Protective Trim

1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.

2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1” LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.

3. Where plates are applied to fire rated doors with the top of the plate more than 16” above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer’s catalog and template book for specific requirements for size and applications.

4. Protection Plates: ANSI/BHMA A156.6 protection plates (kick, armor, or mop), fabricated from the following:

   a. Stainless Steel: 300 grade, 050-inch thick.

5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.

6. Manufacturers:

   a. Hager Companies (HA).

   b. Ives (IV).

   c. Rockwood (RO).

   d. Trimco (TC).

2.13 DOOR STOPS AND HOLDERS

A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.

B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.

1. Manufacturers:

a. Hager Companies (HA).

b. Ives (IV).

c. Rockwood (RO).

d. Trimco (TC).

C. Overhead Door Stops and Holders: ANSI/BHMA A156.8, Grade 1 Certified Products Directory (CPD) listed overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.

1. Manufacturers:

a. dormakaba (DO).

b. Norton Rixson (RF).

c. Sargent Manufacturing (SA).

2.14 ARCHITECTURAL SEALS

A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.

B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.

1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.

C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.

1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NFPA 252, Standard Methods of Fire Tests of Door Assemblies.

D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.

E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

F. Manufacturers:

1. National Guard Products (NG).

2. Pemko (PE).

3. Reese Enterprises, Inc. (RE).

4. Zero (ZE).

2.15 ELECTRONIC ACCESSORIES

A. Door Position Switches: Door position magnetic reed contact switches specifically designed for use in commercial door applications. On recessed models the contact and magnetic housing snap-lock into a 1" diameter hole. Surface mounted models include wide gap distance design complete with armored flex cabling. Provide SPDT, N/O switches with optional Rare Earth Magnet installation on steel doors with flush top channels.

1. Manufacturers:

a. Sargent Manufacturing (SA) - 3280 Series.

b. Security Door Controls (SD) - DPS Series.

c. Securitron (SU) - DPS Series.

B. Intelligent Switching Power Supplies: Provide power supplies with single, dual or multi-voltage configurations at 12 and/or 24VDC. Power Supply shall have battery backup function with an integrated battery charging circuit. The power supply shall have a standard, integrated Fire Alarm Interface (FAI). The power supply shall provide capability for secondary voltage, power distribution, direct lock control and network monitoring through add on modules. The power supply shall be expandable up to 16 individually protected outputs. Output modules shall provide individually protected, continuous outputs and/or individually protected, relay controlled outputs. Network modules shall provide remote monitoring functions such as status reporting, fault reporting and information logging.

1. Provide the least number of units, at the appropriate amperage level, sufficient to exceed the required total draw for the specified electrified hardware and access control equipment.

2. Manufacturers:

a. Securitron (SU) - AQL Series.

b. Altronix (AS) - Maximal 11F.

2.16 FABRICATION

A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.17 FINISHES

A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware

C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.02 PREPARATION

A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.

B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.03 INSTALLATION

A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.

1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.

B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:

1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."

2. DHI TDH-007-20: Installation Guide for Doors and Hardware.

3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."

4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.

C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

D. Push Plates and Door Pulls: When through-bolt fasteners are in the same location as a push plate, countersink the fasteners flush with the door face allowing the push plate to sit flat against the door.

E. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

F. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.04 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.05 CLEANING AND PROTECTION

A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.

B. Clean adjacent surfaces soiled by door hardware installation.

C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.06 DEMONSTRATION

A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.07 DOOR HARDWARE SETS

A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

1. Quantities listed are for each pair of doors, or for each single door.

2. The supplier is responsible for handing and sizing all products.

3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.

4. At existing openings with new hardware the supplier shall field inspect existing conditions prior to the submittal stage to verify the specified hardware will work as required. Provide alternate solutions and proposals as needed.

SECTION 088000 - GLAZING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Work Results:

B. Principal Products:

C. Section includes:
1. Glass for windows, doors, interior borrowed lites, storefront framing, glazed curtain walls.
2. Glazing sealants and accessories.
3. Spandrel Insulation.

1.3 DEFINITIONS

A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

C. IBC: International Building Code.

D. Interspace: Space between lites of an insulating-glass unit.

1.4 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review temporary protection requirements for glazing during and after installation.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Glass Samples: For each type of the following products; 12 inches square.
1. Coated glass.
2. Insulating glass.

C. Glazing Accessory Samples: For sealants and colored spacers, in 12-inch lengths. Install sealant Samples between two strips of material representative in color of the adjoining framing system.

D. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

E. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer manufacturers of insulating-glass units with sputter-coated, low-E coatings glass testing agency and sealant testing agency.

B. Product Certificates: For glass.

C. Product Test Reports: For coated glass insulating glass and glazing sealants, for tests performed by a qualified testing agency.
1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.

D. Preconstruction adhesion and compatibility test report.

E. Sample Warranties: For special warranties.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved and certified by coated-glass manufacturer.

B. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.

D. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

E. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.
   1. Install glazing in mockups specified in Section 084113 "Aluminum-Framed Entrances and Storefronts" Section 084413 "Glazed Aluminum Curtain Walls" to match glazing systems required for Project, including glazing methods.

1.9 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Test each glass product, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.
   1. Testing is not required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.
   2. Use ASTM C 1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
   3. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
   4. Schedule enough time for testing and analyzing results to prevent delaying the Work.
   5. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including the use of specially formulated primers.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

1.11 FIELD CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
   1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F.

1.12 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
   1. Warranty Period: 10 years from date of Final Acceptance.

B. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
   1. Warranty Period: 10 years from date of Final Acceptance.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. HYPERLINK "http://www.specagent.com/Lookup?ulid=9297" Basis-of-Design Product: Subject to compliance with requirements, provide Guardian Industries Corp.: SunGuard or a comparable product by one of the following:
   1. AGC Glass Company North America, Inc.
   2. PPG Flat Glass; PPF Industries, Inc.; Solarban 70XL.
   3. Pilkington North America.

B. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.
   1. Obtain tinted glass from single source from single manufacturer.
   2. Obtain reflective-coated glass from single source from single manufacturer.

C. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

2.2 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design glazing.

C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the IBC and ASTM E 1300.
   1. Design Wind Pressures: As indicated on Structural Drawings, See S-001.
   2. Thickness of Patterned Glass: Base design of patterned glass on thickness at thinnest part of the glass.
   3. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch, whichever is less.
   4. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.

D. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

E. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
   1. For monolithic-glass lites, properties are based on units with lites 6 mm thick.
   2. For laminated-glass lites, properties are based on products of construction indicated.
   3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
   4. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F.
   5. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
   6. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.3 GLASS PRODUCTS, GENERAL

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
   1. GANA Publications: "Glazing Manual."
   2. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR A7, "Sloped Glazing Guidelines."
   3. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Guidelines for Sloped Glazing."
   4. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."

B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.

D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.

E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.4 GLASS PRODUCTS

A. Clear Annealed Float Glass: ASTM C 1036, Type I, Class 1 (clear), Quality-Q3.

B. Fully Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
   1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

C. Heat-Strengthened Float Glass: ASTM C 1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
   1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

D. Ceramic-Coated Vision Glass: ASTM C 1048, Condition C, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3; and complying with Specification No. 95-1-31 in GANA's "Engineering Standards Manual."

E. Ceramic-Coated Spandrel Glass: ASTM C 1048, Type I, Condition B, Quality-Q3.

2.5 INSULATING GLASS

A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190.
   1. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.
   2. Perimeter Spacer: Thermally broken aluminum.
   3. Desiccant: Molecular sieve or silica gel, or a blend of both.

2.6 GLAZING SEALANTS

A. General:
   1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.

B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.
1. HYPERLINK "http://www.specagent.com/Lookup?ulid=174" Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Dow Corning Corporation.
b. GE Construction Sealants; Momentive Performance Materials Inc.
c. Pecora Corporation.
d. Tremco Incorporated.

2.7 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
2. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

2.8 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, with requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

G. Mineral-Wool Board Spandrel Insulation: ASTM C 612, Type IA; faced on one side with foil-scrim-kraft or foil-scrim-polyethylene vapor retarder, with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84. Nominal density of 4.0 lbs/cu. Ft (65kg/ cu. m), thermal resistivity of 4.3 def F x h x sq ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C); ASTM E 2307 tested as part of a perimeter fire containment system for glass spandrel curtain wall fire containment; Thickness: 2-inches.

H. Decorative Films: See Finish Legend.

2.9 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
   1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
      a. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.

C. Grind smooth and polish exposed glass edges and corners.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
   1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
   2. Presence and functioning of weep systems.
   3. Minimum required face and edge clearances.
   4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.

C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

F. Provide spacers for glass lites where length plus width is larger than 50 inches.
   1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
   2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until right before each glazing unit is installed.

F. Apply heel bead of elastomeric sealant.

G. Center glass lites in openings on setting blocks, and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to

edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

D. INSTALLATION OF CURTAIN WALL GLAZING.

E. Install board insulation in curtain-wall construction according to curtain-wall manufacturer's written instructions.

F. Hold insulation in place by securing with silicone adhesive compatible with Silicone Opacifying Coating Spandrel or foil tape creating integral pockets within window frames, spaced at intervals recommended in writing by insulation manufacturer to hold insulation securely in place without touching spandrel glass. Maintain cavity width of dimension indicated on Drawings between insulation and glass.

G. Install insulation to fit snugly without bowing.

3.7 CLEANING AND PROTECTION

A. Immediately after installation remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
   1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

C. Remove and replace glass that is damaged during construction period.

D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Final Acceptance. Wash glass as recommended in writing by glass manufacturer.

3.8 MONOLITHIC GLASS SCHEDULE

A. Glass Type GL-1: Clear fully tempered float glass.
   1. Minimum Thickness: 6 mm.
   2. Safety glazing required.

3.9 INSULATING GLASS SCHEDULE

A. Glass Type GL-2: Double Glazed, Low-E-coated, clear insulating glass with laminated interlayer.
   1. Basis-of-Design Product: SNX 62/27 ON CLEAR w/ Laminated Inboard.
   2. Overall Unit Thickness: 1 5/16 inch.
   3. Minimum Thickness of Each Glass Lite: 6 mm.
   4. Outdoor Lite: Fully tempered float glass.
   5. Interspace Content: Air.
   6. Indoor Lite: Fully tempered float glass.
   7. Inner Layer: Polynvinyl butyral plastic interlayer, clear, 0.060 inch thick.
   8. Inboard lite: fully tempered float glass.
   9. Low-E Coating: Sputtered on second surface.
   10. Winter Nighttime U-Factor: 0.28 maximum.
   11. Summer Daytime U-Factor: 0.26 maximum.
   12. Visible Light Transmittance: 60 percent minimum.
   13. Solar Heat Gain Coefficient: 0.26 maximum.
   14. Safety glazing required.

B. Glass Type GL-3: Low-E-coated, clear insulating glass;
   1. Basis-of-Design Product: SNX 62/27 ON CLEAR SUNGUARD BY GUARDIAN GLASS.
   2. Overall Unit Thickness: 1 inch.
   3. Minimum Thickness of Each Glass Lite: 6 mm.
   4. Outdoor Lite: Fully tempered float glass.
   5. Interspace Content: Air.
   6. Indoor Lite: Fully tempered float glass.
   7. Etch Pattern:
      a. Applied to 1st surface.
      b. Color: Architect to select from full range of manufacture's available colors.
      c. Pattern: Bird1st etch SqX24.
   8. Low-E Coating: Sputtered on second surface.
   9. Winter Nighttime U-Factor: 0.28 maximum.
   10. Summer Daytime U-Factor: 0.26 maximum.
   11. Visible Light Transmittance: 62 percent minimum.
   12. Solar Heat Gain Coefficient: 0.26 maximum.
   13. Safety glazing required.

END OF SECTION 088000

SECTION 088300 - MIRRORS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes the following types of silvered flat glass mirrors:
   1. Tempered glass mirrors qualifying as safety glazing.

B. Related Requirements:
   1. Section 088000 "Glazing" for glass with reflective coatings used for vision and spandrel lites.
   2. Section 102800 "Toilet, Bath, and Laundry Accessories" for metal-framed mirrors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Mirrors. Include description of materials and process used to produce each type of silvered flat glass mirror specified that indicates sources of glass, glass coating components, edge sealer, and quality-control provisions.

B. Shop Drawings: Include mirror elevations, edge details, mirror hardware, and attachment details.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For mirrors to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect mirrors according to mirror manufacturer's written instructions and as needed to prevent damage to mirrors from moisture, condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not install mirrors until ambient temperature and humidity conditions are maintained at levels indicated for final occupancy.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to replace mirrors that deteriorate within specified warranty period. Deterioration of mirrors is defined as defects developed from normal use that are not attributed to mirror breakage or to maintaining and cleaning mirrors contrary to manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.
   1. Warranty Period: Five years from date of Final Acceptance.

PART 2 PRODUCTS

2.1 SILVERED FLAT GLASS MIRRORS (088300.00)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Trulite Glass & Aluminum Solutions, LLC.
   2. Virginia Mirror Company, Inc.
   3. Walker Glass Co., Ltd.

B. Source Limitations for Mirrors: Obtain mirrors and glazing accessories from single source from single manufacturer.

C. Mirrors, General: ASTM C 1503; manufactured using copper-free, low-lead mirror coating process.

D. Tempered Glass Mirrors: Mirror Glazing Quality for blemish requirements and complying with ASTM C 1048 for Kind FT, Condition A, tempered float glass before silver coating is applied; clear.
   1. Nominal Thickness: 6.0 mm.
   2. Edge: Flat Polished.
   3. Tint Color: None.

E. Safety Glazing Products: For tempered mirrors, provide products that comply with 16 CFR 1201, Category II.

2.2 MISCELLANEOUS MATERIALS

A. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

B. Edge Sealer: Coating compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at mirrored glass edges.

C. Mirror Mastic: An adhesive setting compound, asbestos-free, produced specifically for setting mirrors and certified by both mirror and mastic manufacturer as compatible with glass coating and substrates on which mirrors will be installed.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Franklin International.
      b. Laurence, C. R. Co., Inc.
      c. Liquid Nails Adhesive.
      d. Macco Adhesives.
      e. OSI Sealants; Henkel Corporation.
      f. Palmer Products Corporation.
      g. Pecora Corporation.
      h. Royal Adhesives & Sealants.
      i. Sommer & Maca Industries, Inc.

2.3 MIRROR HARDWARE

A. Mechanical Fasteners:
   1. Profile: J-molding at bottom of mirror.
   2. Finish: Architect to select from manufacturers full range.

2.4 FABRICATION

A. Fabricate mirrors in the shop to greatest extent possible.

B. Fabricate cutouts for notches and holes in mirrors without marring visible surfaces. Locate and size cutouts so they fit closely around penetrations in mirrors.

C. Mirror Edge Treatment: Flat polished.
   1. Seal edges of mirrors with edge sealer after edge treatment to prevent chemical or atmospheric penetration of glass coating.
   2. Require mirror manufacturer to perform edge treatment and sealing in factory immediately after cutting to final sizes.

D. Film-Backed Safety Mirrors: Apply film backing with adhesive coating over mirror backing

paint, as recommended in writing by film-backing manufacturer, to produce a surface free of bubbles, blisters, and other imperfections.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, over which mirrors are to be mounted, with Installer present, for compliance with installation tolerances, substrate preparation, and other conditions affecting performance of the Work.

B. Verify compatibility with and suitability of substrates, including compatibility of existing finishes or primers with mirror mastic.

C. Proceed with installation only after unsatisfactory conditions have been corrected and surfaces are dry.

3.2 PREPARATION

A. Comply with mastic manufacturer's written installation instructions for preparation of substrates, including coating substrates with mastic manufacturer's special bond coating where applicable.

3.3 INSTALLATION

A. General: Install mirrors to comply with mirror manufacturer's written instructions and with referenced GANA publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.
   1. GANA Publications: "Laminated Glazing Reference Manual," "Glazing Manual" and "Mirrors, Handle with Extreme Care: Tips for the Professional on the Care and Handling of Mirrors."

B. Provide a minimum airspace of 1/8 inch between back of mirrors and mounting surface for air circulation between back of mirrors and face of mounting surface.

C. Install mirrors with mastic and mirror hardware. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors.
   1. Aluminum J-Channels: Provide setting blocks 1/8 inch thick by 4 inches long at quarter points. To prevent trapping water, provide, between setting blocks, two slotted weeps not less than 1/4 inch wide by 3/8 inch long at bottom channel.
   2. Aluminum J-Channels and Cleat: Fasten J-channel directly to wall and attach top trim to continuous cleat fastened directly to wall.
   3. Mirror Clips: Place a felt or plastic pad between mirror and each clip to prevent spalling of mirror edges. Locate clips so they are symmetrically placed and evenly spaced.
   4. Install mastic as follows:
      a. Apply barrier coat to mirror backing where approved in writing by manufacturers of

mirrors and backing material.

b. Apply mastic to comply with mastic manufacturer's written instructions for coverage and to allow air circulation between back of mirrors and face of mounting surface.
c. After mastic is applied, align mirrors and press into place while maintaining a minimum airspace of 1/8 inch between back of mirrors and mounting surface.

3.4 CLEANING AND PROTECTION

A. Protect mirrors from breakage and contaminating substances resulting from construction operations.

B. Do not permit edges of mirrors to be exposed to standing water.

C. Maintain environmental conditions that prevent mirrors from being exposed to moisture from condensation or other sources for continuous periods of time.

D. Clean exposed surface of mirrors not more than four days before date scheduled for inspections that establish date of Final Acceptance. Clean mirrors as recommended in writing by mirror manufacturer.

END OF SECTION 088300

SECTION 088400 - PLASTIC GLAZING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:
   1. Monolithic polycarbonate glazing at Amphitheater Roof.
   2. Glazing accessories.

1.3 DEFINITIONS

A. Glazing Manufacturers: Firms that produce primary polycarbonate sheet glazing as defined in referenced glazing publications.

B. Glazing Thicknesses: Indicated by thickness designations in millimeters.

C. IBC: International Building Code.

1.4 COORDINATION

A. Coordinate glazing requirements with existing conditions; intent is for corrugated polycarbonate glazing to match existing size, profile, and fastening pattern.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   2. Review temporary protection requirements for glazing during and after installation.
   3. Confirm compatibility with existing system and conditions.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Glass Samples: Provide 12 inch square physical sample of each specified glazing type.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer manufacturers of polycarbonate sheet glazing testing agency and sealant testing agency.

B. Product Certificates: For polycarbonate sheet glazing.

C. Preconstruction adhesion and compatibility test report.
   1. Include written statement confirming submitted product matches existing roof system. Provide photo documentation of submitted product in comparison to existing.

D. Sample Warranties: For special warranties.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Test each polycarbonate glazing product, tape sealant, gasket, glazing accessory, and framing member for adhesion to and compatibility with elastomeric glazing sealants.
   1. Testing is not required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.
   2. Use ASTM C 1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
   3. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
   4. Schedule enough time for testing and analyzing results to prevent delaying the Work.
   5. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including the use of specially formulated primers.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
   1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F.

1.11 WARRANTY

A. Manufacturer's Special Warranty for.
   1. Warranty Period: 10 years from date of Final Acceptance.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain plastic glazing from single source from single manufacturer. Obtain sealants and gaskets from single source from single manufacturer for each product and installation method.

2.2 PERFORMANCE REQUIREMENTS:

A. Plastic glazing sheets and glazing materials shall withstand normal temperature changes, wind, and impact loads without failure, including loss or breakage of plastic sheets attributable to the following: failure of sealants or gaskets to remain watertight and airtight, deterioration of plastic sheet and glazing materials, or other defects in materials and installation.

B. Safety Glazing: Plastic glazing shall comply with 16 CFR 1201, Category II.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on plastic glazing and glazing framing members.
   1. Temperature Change: 120 deg F (), ambient; 180 deg F (), material surfaces.

D. Fire-Test-Response Characteristics of Plastic Glazing: As determined by testing plastic glazing by a qualified testing agency acceptable to authorities having jurisdiction.
   1. Self-ignition temperature of 650 deg F (343 deg C) or higher when tested according to ASTM D1929 on plastic sheets in thicknesses indicated for the Work.
   2. Smoke density of 75 or less when tested according to ASTM D2843 on plastic sheets in thicknesses indicated for the Work.
   3. Burning extent of 1 inch (25 mm) or less when tested according to ASTM D635 at a nominal thickness of 0.060 inch (1.52 mm) or thickness indicated for the Work, where Class CC1 is indicated.
   4. Flame-spread index of not less than that indicated when tested according to ASTM E84.

2.3 MONOLITHIC POLYCARBONATE GLAZING

A. Plastic Glazing, Polycarbonate Solid Corrugated Sheet: ASTM C1349, Appendix X1, Type I (standard, UV stabilized), with a polished finish.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Amerilux International, LLC.
      b. Palram Americas Ltd.
      c. SABIC Innovative Plastics IP BV.
   2. Nominal Thickness: 8mm or existing panel thickness, whichever is greater.

3. Color: Transparent colorless, Clear: 90%.
4. Profile: Sine Wave Corrugation; Match existing rib spacing and panel overall thickness.
5. Combustibility Class: CC1.
6. Panel Size: Match existing panel size and fastening pattern, unless otherwise directed by manufacturer.

2.4 MISCELLANEOUS GLAZING MATERIALS

A. Compatibility: Provide products of material, size, and shape complying with requirements of manufacturers of plastic glazing and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

2.5 FABRICATION

A. Sizes: Fabricate plastic glazing to sizes required for openings indicated. Allow for thermal expansion and contraction of plastic glazing without restraint and without withdrawal of edges from frames, with edge clearances and tolerances complying with plastic glazing manufacturer's written instructions.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine plastic glazing framing, with glazing Installer present, for compliance with the following:
   1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
   2. Minimum required face or edge clearances.
   3. Effective sealing between joints of plastic glazing framing members.

B. Proceed with glazing only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with

edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.

C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

D. Sand or scrape cut edges of plastic glazing to provide smooth edges, free of chips and hairline cracks.

E. Remove burrs and other projections from glazing channel surfaces.

F. Protect plastic glazing surfaces from abrasion and other damage during handling and installation, according to the following requirements:
   1. Retain plastic glazing manufacturer's protective covering or protect by other methods according to plastic glazing manufacturer's written instructions.
   2. Remove covering at border of each piece before glazing; remove remainder of covering immediately after installation where plastic glazing is exposed to sunlight or where other conditions make later removal difficult.
   3. Remove damaged plastic glazing sheets from Project site and legally dispose of off-site. Damaged plastic glazing sheets are those containing imperfections that, when installed, result in weakened glazing and impaired performance and appearance.

3.4 CLEANING AND PROTECTION

A. Immediately after installation remove nonpermanent labels and clean surfaces.

B. Protect plastic glazing from contact with contaminating substances from construction operations. If, despite such protection, contaminating substances do come into contact with plastic glazing, remove immediately and wash plastic glazing according to plastic glazing manufacturer's written instructions.

C. Remove and replace plastic glazing that is broken, chipped, cracked, abraded, or damaged in other ways during construction period, including natural causes, accidents, and vandalism.

D. Wash plastic glazing on both faces before date scheduled for inspections intended to establish date of Final Acceptance in each area of Project. Wash plastic glazing according to plastic glazing manufacturer's written instructions.

END OF SECTION 088400

SECTION 088853 - -SECURITY GLAZING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes laminated polycarbonate for the following applications:
   1. Windows.

1.3 DEFINITIONS

A. Glazing Manufacturers: Firms that produce primary glass, monolithic plastic glazing, or fabricated security glazing, as defined in referenced glazing publications.

B. Interspace: Space between lites of air-gap security glazing or insulating security glazing.

1.4 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on security glazing, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Security Glazing Samples: For each type of security glazing; 12 inches (300 mm) square.

C. Security Glazing Schedule: List security glazing types and thicknesses for each size opening and location. Use same designations indicated on Drawings. Indicate coordinated dimensions of security glazing and construction that receives security glazing, including clearances and glazing channel dimensions.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For glazing testing agency.

B. Product Certificates: For each type of product indicated, from manufacturer.

C. Product Test Reports: For each type of security glazing, for tests performed by a qualified testing agency.

D. Product Test Reports: For each type of glazing sealant, for tests performed by a qualified testing agency.
   1. Provide test reports based on testing current sealant formulations within previous 36-month period.

E. Sample Warranties: For special warranties.

1.7 QUALITY ASSURANCE

A. Security Glazing Testing Agency Qualifications: Subject to compliance with requirements, testing agency is one of the following:
   1. H. P. White Laboratory, Inc.
   2. Underwriters Laboratories, Inc.
   3. Wiss, Janney, Elstner Associates, Inc.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect security glazing and glazing materials according to manufacturer's written instructions. Prevent damage from condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with insulating security glazing and with air-gap security glazing manufacturers' written recommendations for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.9 WARRANTY

A. Manufacturer's Special Warranty for Coated Glass: Manufacturer agrees to replace coated glass that deteriorates within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
   1. Warranty Period: 10 years from date of Final Acceptance.

B. Manufacturer's Special Warranty for Laminated Polycarbonate: Manufacturer agrees to replace laminated polycarbonate that deteriorates within specified warranty period. Deterioration of laminated polycarbonate is defined as defects developed from normal use that are not attributed to maintaining and cleaning laminated polycarbonate contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glazing, blemishes exceeding those allowed by referenced standard, yellowing, and loss of light transmission.
   1. Warranty Period: Five years from date of Final Acceptance.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Glazing Gaskets: Obtain from single source from single manufacturer for each product and installation method.

2.2 PERFORMANCE REQUIREMENTS

A. General:
   1. Installed security glazing shall withstand security-related loads and forces without damage to the glazing beyond that allowed by referenced standards.

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements", to design security glazing.

C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated.

2.3 SECURITY GLAZING, GENERAL

A. Glazing Publications: Comply with published recommendations of security glazing and glazing material manufacturers and organizations below unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.

B. Plastic Glazing Labeling: Identify plastic sheets with appropriate markings of applicable testing and inspecting agency, indicating compliance with required fire-test-response characteristics.

C. Fire-Test-Response Characteristics of Polycarbonate Sheets: As determined by testing polycarbonate sheets identical to those used in security glazing products by a qualified testing agency acceptable to authorities having jurisdiction.
   1. Self-ignition temperature of 650 deg F (343 deg C) or more when tested according to ASTM D 1929 on plastic sheets in thicknesses indicated for the Work.
   2. Smoke-Developed Index of 450 or less when tested according to ASTM E 84, or smoke density of 75 or less when tested according to ASTM D 2843 on plastic sheets in thicknesses indicated for the Work.
   3. Burning extent of 1 inch (25 mm) or less when tested according to ASTM D 635 at a nominal thickness of 0.060 inch (1.52 mm) or thickness indicated for the Work.

2.4 POLYCARBONATE SECURITY GLAZING

A. Laminated Polycarbonate: Polycarbonate sheets laminated with clear urethane interlayer that complies with ASTM C 1349, Appendix X2, and has a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

Provide laminated units that comply with requirements of ASTM C 1349 for maximum allowable laminating process blemishes and haze.

2.5 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of security glazing and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by security glazing manufacturer to maintain security glazing lites in place for installation indicated.

E. Edge Blocks: Elastomeric material of hardness needed to limit security glazing lateral movement (side walking).

F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

2.6 FABRICATION OF SECURITY GLAZING

A. Fabricate security glazing in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine framing for security glazing, with Installer present, for compliance with the following:
   1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
   2. Minimum required face or edge clearances.
   3. Minimum required bite.
   4. Effective sealing between joints of framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving security glazing immediately before glazing. Remove coatings not firmly bonded to substrates.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of security glazing, sealants, gaskets, and other glazing materials unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Protect edges of security glazing from damage during handling and installation. Remove damaged security glazing from Project site and legally dispose of off Project site. Damaged security glazing includes units with edge or face damage or other imperfections that, when installed, could weaken security glazing and impair performance and appearance.

C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications unless otherwise required by glazing unit manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

E. Do not exceed edge pressures stipulated by security glazing manufacturers for installing lites.

F. Provide spacers for security glazing lites where the length plus width is larger than 50 inches (1270 mm).
   1. Locate spacers directly opposite each other on both inside and outside faces of security glazing. Install correct size and spacing to preserve required face clearances unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with performance requirements.
   2. Provide 1/8-inch (3-mm) minimum bite of spacers on glazing lites and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

G. Provide edge blocking where indicated or needed to prevent security glazing from moving sideways in glazing channel, as recommended in writing by security glazing manufacturer and according to requirements in referenced glazing publications.

H. Set security glazing in each series with uniform pattern, draw, bow, and similar characteristics.

I. Set coated security glazing with proper orientation so that coatings and films face exterior or interior as specified.

J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by

gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket securely in place between glazing unit and frame or fixed stop, so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center security glazing in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in security glazing. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center security glazing in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in security glazing. Seal gasket joints with sealant recommended by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.5 CLEANING AND PROTECTION

A. Immediately after installation remove nonpermanent labels and clean surfaces.

B. Protect security glazing from contact with contaminating substances resulting from construction operations, including weld splatter. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
   1. If, despite such protection, contaminating substances do come into contact with security glazing, remove substances immediately as recommended in writing by security glazing manufacturer. Remove and replace security glazing that cannot be cleaned without damage.

C. Wash security glazing on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Final Acceptance. Wash security glazing as recommended in writing by security glazing manufacturer.

3.6 LAMINATED-POLYCARBONATE SECURITY GLAZING SCHEDULE

A. Security Glazing: Laminated polycarbonate.
   1. Products: Subject to compliance with requirements, available products that may be

incorporated into the Work include, but are not limited to, the following:

a. Total Security Solutions.
b. C.R. Laurence Co., Inc.
c. Interbank Equipment.

2. Detention Security Grade: Grade 3 according to ASTM F 1915 cold-temperature impact test, warm-temperature impact test, and torch and small blunt impactor test.
3. Interlayer Material: Polyurethane.

END OF SECTION 088853

SECTION 089119 - FIXED LOUVERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Fixed extruded-aluminum louvers.

1.3 DEFINITIONS

A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. Horizontal Louver: Louver with horizontal blades (i.e., the axis of the blades are horizontal).

C. Wind-Driven-Rain-Resistant Louver: Louver that provides specified wind-driven-rain performance, as determined by testing according to AMCA 500-L.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.
   1. Show weep paths, gaskets, flashings, sealants, and other means of preventing water intrusion.
   2. Show mullion profiles and locations.

C. Samples: For each type of metal finish required.

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.

B. Sample Warranties: For manufacturer's special warranties.

1.6 QUALITY ASSURANCE

1.7 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.8 WARRANTY

A. Special Finish Warranty: Manufacturer agrees to repair or replace components on which finishes fail in materials or workmanship within specified warranty period.
   1. Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
   2. Warranty Period: Five years from date of Final Acceptance.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain fixed louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

2.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
   1. Wind Loads: Determine loads based on a uniform pressure of 20 lbf/sq. ft., acting inward or outward.

B. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for

length and width according to AMCA 500-L.

C. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

2.3 FIXED EXTRUDED-ALUMINUM LOUVERS

A. Horizontal, Wind-Driven-Rain-Resistant Louver:
   1. Louver Depth: 5 inches.
   2. Frame and Blade Nominal Thickness: Not less than 0.063 inch for blades and 0.081 inch for frames.
   3. Louver Performance Ratings:
      a. Free Area: Not less than 7.59 sq. ft. for 48-inch- wide by 48-inch- high louver.
      b. Air Performance: Not more than 0.10-inch W.C. static pressure drop at 450-fpm free-area exhaust velocity.
      c. Wind-Driven Rain Performance: Not less than 99 percent effectiveness when subjected to a rainfall rate of 3 inches per hour and a wind speed of 29 mph at a core-area intake velocity of 500 fpm.
   4. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.4 MATERIALS

A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5, T-52, or T6.

B. Fasteners: Use types and sizes to suit unit installation conditions.
   1. Use tamper-resistant screws for exposed fasteners unless otherwise indicated.
   2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
   3. For fastening stainless steel, use 300 series stainless-steel fasteners.
   4. For color-finished louvers, use fasteners with heads that match color of louvers.

C. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, fabricated from stainless-steel components, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing according to ASTM E 488/E 488M conducted by a qualified testing agency.

D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

2.5 FABRICATION

A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

C. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
   1. Frame Type: Exterior flange unless otherwise indicated.

D. Include supports, anchorages, and accessories required for complete assembly.

E. Provide vertical mullions of type and at spacings indicated, but not more than is recommended by manufacturer.
   1. Fully Recessed Mullions: Where indicated, provide mullions fully recessed behind louver blades. Where length of louver exceeds fabrication and handling limitations, fabricate with close-fitting blade splices designed to permit expansion and contraction.
   2. Semirecessed Mullions: Where indicated, provide mullions partly recessed behind louver blades, so louver blades appear continuous. Where length of louver exceeds fabrication and handling limitations, fabricate with interlocking split mullions and close-fitting blade splices designed to permit expansion and contraction.

F. Provide extended sills for recessed louvers.

G. Join frame members to each other and to fixed louver blades with fillet welds concealed from view unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.6 ALUMINUM FINISHES

A. High-Performance Organic Finish: Three-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   1. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Protect unpainted galvanized- and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

F. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 079200 "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

C. Restore louvers damaged during installation and construction, so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
   1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 089119

SECTION 092116 - GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Performance criteria for gypsum board assemblies.

B. Metal stud wall framing.

C. Metal channel ceiling framing.

D. Acoustic insulation and acoustic sealant.

E. Gypsum wallboard including backing board for wet areas.

F. Joint treatment and accessories.

1.2 RELATED REQUIREMENTS

A. Section 054000 - Cold-Formed Metal Framing: Structural steel stud framing.

B. Section 061000 - Rough Carpentry: Wood blocking product and execution requirements.

C. Section 078400 - Firestopping: Top-of-wall assemblies at fire-resistance-rated walls.

D. Section 079200 - Joint Sealants: Sealing gaps in construction other than gypsum board or plaster work.

E. Section 083100 - Access Doors and Panels: Access panels.

F. Section 123600 - Countertops: Countertop support brackets with concealed vertical leg.

1.3 DEFINITIONS

A. Wet Areas: Wet areas include the following:
   1. Walls supporting sinks, toilets and urinals.

1.4 REFERENCE STANDARDS

A. AISI S220 - North American Standard for Cold-Formed Steel Framing - Nonstructural Members; 2015.

B. AISI S240 - North American Standard for Cold-Formed Steel Structural Framing; 2015, with Errata (2020).

C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.

D. ASTM A1003/A1003M - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members; 2015.

E. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board; 2017 (Reapproved 2022).

F. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2023.

G. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2020.

H. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2020.

I. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness; 2022.

J. ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base; 2019.

K. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2017.

L. ASTM C1658/C1658M - Standard Specification for Glass Mat Gypsum Panels; 2019, with Editorial Revision (2020).

M. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber; 2021.

N. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2023.

O. ASTM E413 - Classification for Rating Sound Insulation; 2022.

P. GA-216 - Application and Finishing of Gypsum Panel Products; 2021.

Q. UL (FRD) - Fire Resistance Directory; Current Edition.

1.5 SUBMITTALS

A. Product Data: Provide data on metal framing, accessories, joint finishing system, and each type of board material specified.

B. Shop Drawings: Indicate special details associated with fireproofing.

1.6 QUALITY ASSURANCE

1.7 DELIVERY, STORAGE, AND HANDLING

A. See Section 01 74 19 - Construction Waste Management and Disposal for packaging waste requirements.

B. Store gypsum products and accessories indoors and keep above freezing. Elevate boards above floor, on nonwicking supports, in accordance with manufacturer's recommendations.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

PART 2 PRODUCTS

2.1 GYPSUM BOARD ASSEMBLIES

A. Provide completed assemblies complying with ASTM C840 and GA-216.
   1. See PART 3 for finishing requirements.

B. Interior Partitions: Provide completed assemblies with the following characteristics:
   1. Acoustic Attenuation: STC as indicated calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.

C. Shaft Walls at HVAC Shafts: Provide completed assemblies with the following characteristics:
   1. Air Pressure Within Shaft: Sustained loads of 5 lbf/sq ft with maximum mid-span deflection of L/240.
   2. Acoustic Attenuation: STC of 55 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.

D. Fire-Resistance-Rated Assemblies: Provide completed assemblies complying with applicable code..
   1. Fire-Resistance-Rated Ceilings and Soffits: One (1) hour fire rating.
   2. UL Assembly Numbers: Provide construction equivalent to that listed for the particular assembly in the current UL (FRD).

2.2 METAL FRAMING MATERIALS

A. Steel Sheet: ASTM A1003/A1003M, subject to the ductility limitations indicated in AISI S240.

B. Manufacturers - Metal Framing, Connectors, and Accessories:
1. ClarkDietrich Building Systems: www.clarkdietrich.com.
2. Jaimes Industries: www.jaimesind.com/#sle.
3. Marino: www.marinoware.com.
4. SCAFCO Corporation: www.scafco.com/#sle.
5. Telling Industries, LLC; www.buildstrong.com.

C. Nonstructural Framing System Components: AISI S220; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/120 at 5 psf.
1. Minimum Base Metal Thickness: 0.0247 inch (0.626 mm) 25 ga. in all locations unless otherwise required to be 0.0396 inch (1.005 mm) 20 ga. where the following conditions exist:
a. Where the floor to floor height (limiting height) exceeds the allowable deflection of 0.0247 inch (0.626 mm) 25 ga. studs.
b. At stair shafts, elevator hoistways, and other vertical shafts.
c. At partitions to receive stone cladding, ceramic tile, cementitious backer board, abuse-resistant gypsum board, plywood, wood panels, projection screens, marker or chalkboards, veneer plaster, gypsum plaster or interior portland cement plaster.
d. At partitions to receive cabinets, countertops, shelving, other wall supported millwork, casework, furniture items, wall-hung plumbing fixtures without chair carriers, countertop support brackets and equipment either furnished and installed by the Contractor, furnished and installed by the Owner or furnished by the Owner and installed by the Contractor.
e. At framing for door frames; refer to Part 3, Installing Framed Assemblies.
f. At cantilevered furring and miscellaneous framing supports.
g. At fire-rated and STC-rated partitions where required by the UL-listing or other testing agency.
h. Note: All of the above mentioned materials may not be used on this project.
2. Studs: C-shaped with knurled or embossed faces.
3. Runners: U shaped, sized to match studs.
4. Ceiling Channels: C-shaped.
5. Furring Members: Hat-shaped sections, minimum depth of 7/8 inch.
6. Furring Members: Zee-shaped sections, minimum depth of 1 inch.
7. Resilient Furring Channels: Single or double leg configuration; 1/2 inch channel depth.

D. Area Separation Wall Studs and Accessories: AISI S220; galvanized sheet steel, of size and properties necessary to comply with specified performance requirements.

E. Partition Head To Structure Connections at Non-Rated Walls: Provide track fastened to structure with legs of sufficient length to accommodate minimum 1 inch deflection, for friction fit of studs cut short.

F. Partition Head to Structure Connections at Rated Walls: Provide mechanical anchorage devices that accommodate minimum 1 inch deflection using slotted holes, screws and anti-friction bushings, preventing rotation of studs while maintaining structural performance of partition.
   1. Material: ASTM A653/A653M steel sheet, SS Grade 50/340, with G60/Z180 hot-dipped galvanized coating.
   2. Provide components UL-listed for use in UL-listed fire-resistance-rated head of partition joint systems indicated on drawings.
   3. Provide mechanical anchorage devices as described above that accommodate deflection while maintaining the fire-resistance rating of the wall assembly.

G. Deflection and Firestop Track: Intumescent strip factory-applied to track flanges expands when exposed to heat or flames to provide a perimeter joint seal.
   1. Products:
      a. ClarkDietrich; BlazeFrame Firestop Deflection Track: www.clarkdietrich.com/#sle.
      b. Fire Track Corp.; Shadowline.
      c. Marino; Deflection Drift Angle.
      d. Telling Industries; Deflection and Firestopping Track.

H. Non-structural Framing Accessories:
   1. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.
   2. Partial Height Wall Framing Support: Provides stud reinforcement and anchored connection to floor.
   3. Framing Connectors: ASTM A653/A653M G90 galvanized steel clips; secures cold rolled channel to wall studs for lateral bracing.

I. Countertop Support Brackets with concealed vertical leg: Coordinate with specification Section 12 36 00 - Countertops, if applicable.

2.3 GYPSUM BOARD, GENERAL

A. Regional Materials: Gypsum panel products shall be manufactured within 500 miles (800 km) of Project site.

B. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.4 BOARD MATERIALS

A. Manufacturers - Gypsum-Based Board:
   1. American Gypsum Company: www.americangypsum.com/#sle.
   2. CertainTeed Corporation: www.certainteed.com.
   3. Georgia-Pacific Gypsum: www.gpgypsum.com.
   4. National Gypsum Company: www.nationalgypsum.com/#sle.
   5. USG Corporation: www.usg.com.

B. Gypsum Wallboard: Mold-resistant paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; tapered long edges, ends square cut and meeting the following:
   1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
   2. Glass mat faced gypsum panels, as defined in ASTM C1658/C1658M, suitable for paint finish, of the same core type and thickness may be substituted for paper-faced board.
   3. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
      a. Mold resistant board is required at all locations.
   4. Type: Fire-resistance rated Type X, UL or WH listed.
   5. Thickness:
      a. Vertical Surfaces: 5/8 inch.
      b. Ceilings: 5/8 inch.
      c. Multi-Layer Assemblies: Thicknesses as indicated on drawings.

C. Backing Board For Wet Areas:
   1. Application: Partitions in wet areas including walls supporting sinks, toilets and urinals.
   2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.

D. Backing Board For Non-Wet Areas: Water-resistant gypsum backing board as defined in ASTM C1396/C1396M; sizes to minimum joints in place; ends square cut.
   1. Application: Vertical surfaces behind thinset tile, except in wet areas.
   2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
   3. Type X Thickness: 5/8 inch.
   4. Edges: Tapered.

E. Ceiling Board: Special sag resistant gypsum ceiling board as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
   1. Application: Ceilings, unless otherwise indicated.
   2. Thickness: 5/8 inch.
   3. Edges: Tapered.
   4. Type: Fire-resistance rated Type X, UL or WH listed.
   5. Pressure treated in accordance with ASTM D1760.
   6. Pressure treated.

F. Exterior Sheathing Board: As specified in Section 06 16 43 - GYPSUM SHEATHING.

G. Shaftwall and Coreboard: Type X; 1 inch thick by 24 inches wide, beveled long edges, ends square cut.
   1. Glass Mat Faced Type: Glass mat shaftliner gypsum panel or glass mat coreboard gypsum panel as defined in ASTM C1658/C1658M.
   2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.

2.5 GYPSUM BOARD ACCESSORIES

A. Acoustic Insulation: ASTM C665; preformed mineral fiber, friction fit type, unfaced. Thickness: 3 inch minimum but thicker where required to meet a higher STC rating.

B. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.

C. Finishing Accessories: ASTM C1047, extruded aluminum alloy (6063 T5) or galvanized steel sheet ASTM A924/A924M G90, unless noted otherwise.
   1. Types: As detailed or required for finished appearance.
   2. Special Shapes: In addition to conventional corner bead and control joints, provide U-bead at exposed panel edges.
   3. Products:
      a. Same manufacturer as framing materials.

D. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.
   1. Paper Tape: 2 inch wide, creased paper tape for joints and corners, except as otherwise indicated.
   2. Fiberglass Tape: 2 inch wide, coated glass fiber tape for joints and cornersat assemblies containing glass mat faced board.
   3. Joint Compound: Drying type, vinyl-based, ready-mixed.

E. Screws for Fastening of Gypsum Panel Products to Wood Members and Steel Members from 0.033 to 0.112 inch in Thickness: ASTM C954; steel drill screws, corrosion resistant.

F. Anchorage to Substrate: Tie wire, nails, screws, and other metal supports, of type and size to suit application; to rigidly secure materials in place.

G. Isolation Strip at Exterior Walls: Provide one of the following:
   1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), non-perforated.
   2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that project conditions are appropriate for work of this section to commence.

3.2 SHAFT WALL INSTALLATION

A. Shaft Wall Framing: Install in accordance with manufacturer's installation instructions.
   1. Install studs at spacing required to meet performance requirements.

B. Shaft Wall Liner: Cut panels to accurate dimensions and install sequentially between special friction studs.
   1. Seal perimeter of shaft wall and penetrations with acoustical sealant.

3.3 FRAMING INSTALLATION

A. Metal Framing: Install in accordance with AISI S220 and manufacturer's instructions.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Suspended Ceilings and Soffits: Space framing and furring members as indicated.
   1. Level ceiling system to a tolerance of 1/1200.
   2. Laterally brace entire suspension system.
   3. Install bracing as required at exterior locations to resist wind uplift.

D. Studs: Space studs at 16 inches on center.
   1. Extend partition framing to structure where indicated and to ceiling in other locations.
   2. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.
   3. Partitions Terminating at Structure - Non-Rated: Attach extended leg top runner to structure, maintain clearance between top of studs and structure, and brace both flanges of studs with continuous bridging.
   4. Partitions Terminating at Structure - Rated: Attach top runner to structure, maintain clearance between top of studs and structure, and connect studs to track using specified mechanical devices in accordance with manufacturer's instructions; verify free movement of top of stud connections; do not leave studs unattached to track.

E. Countertop Support Brackets: Install brackets in accordance with manufacturer’s written instructions.
   1. Installation of brackets indicates acceptance of stud gage and installation.
   2. Coordinate with Section 12 36 00 - Countertops.

F. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.

G. Standard Wall Furring: Install at concrete walls scheduled to receive gypsum board, not more than 4 inches from floor and ceiling lines and abutting walls. Secure in place on alternate channel flanges at maximum 24 inches on center.
   1. Orientation: Vertical.

H. Acoustic Furring: Install resilient channels at maximum 24 inches on center. Locate joints over framing members.

I. Blocking: Install mechanically fastened steel sheet blocking or wood blocking for support of:
   1. Framed openings.
   2. Wall-mounted cabinets.
   3. Plumbing fixtures.
   4. Toilet partitions.
   5. Toilet accessories.
   6. Wall-mounted door hardware.
   7. Grab bars.
   8. Coordinate with Section 06 10 00 - Rough Carpentry.

3.4 ACOUSTIC ACCESSORIES INSTALLATION

A. Acoustic Insulation in Walls: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions unless otherwise indicated.

B. Acoustic Sealant: Install in accordance with manufacturer's instructions.
   1. Place one bead continuously on substrate before installation of perimeter framing members.
   2. Place continuous bead at perimeter of each layer of gypsum board.
   3. Seal around all penetrations by conduit, pipe, ducts, and rough-in boxes, except where firestopping is provided.

3.5 BOARD INSTALLATION

A. Comply with ASTM C840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.
   1. Install gypsum board 1/2 inch above surface of slab to prevent wicking of moisture unless otherwise indicated.

B. Single-Layer Nonrated: Install gypsum board in most economical direction, with ends and edges occurring over firm bearing.
   1. Exception: Tapered edges to receive joint treatment at right angles to framing.
   2. Exception: Install gypsum board perpendicular to framing at stairwells and walls in excess of 12 feet in height.

C. Double-Layer, Nonrated: Use gypsum board for first layer, placed parallel to framing or furring members, with ends and edges occurring over firm bearing. Place second layer perpendicular to framing or furring members. Offset joints of second layer from joints of first layer.

D. Fire-Resistance-Rated Construction: Install gypsum board in strict compliance with requirements of assembly listing.

E. Exposed Gypsum Board in Interior Wet Areas: Seal joints, cut edges, and holes with water-resistant sealant.

F. Installation on Metal Framing: Use screws for attachment of gypsum board except face layer of nonrated double-layer assemblies, which may be installed by means of adhesive lamination.

G. Moisture Protection: Treat cut edges and holes in moisture resistant gypsum board with sealant.

3.6 INSTALLATION OF TRIM AND ACCESSORIES

A. Control Joints: Place control joints consistent with lines of building spaces and in accordance with ASTM C 840 in specific locations approved by Architect for visual effect.
   1. Not more than 30 feet apart on walls and ceilings over 50 feet long.

B. Corner Beads: Install at external corners, using longest practical lengths.

C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials.

3.7 JOINT TREATMENT

A. Glass Mat Faced and Water-Resistant Gypsum Board: Use fiberglass joint tape, bedded and finished with chemical hardening type joint compound.

B. Paper Faced Gypsum Board: Use paper joint tape, embed with drying type joint compound and finish with drying type joint compound.

C. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
   1. Level 4: Walls and ceilings to receive paint finish, unless otherwise indicated.
   2. Level 5: Walls and ceilings to recieve wall coverings, unless otherwise indicated.
   3. Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish.
   4. Level 1: Fire-resistance-rated wall areas above finished ceilings, whether or not accessible in the completed construction.

D. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
   1. Feather coats of joint compound so that camber is maximum 1/32 inch.
   2. Taping, filling, and sanding are not required at surfaces behind adhesive applied ceramic tile and fixed cabinetry.
   3. Taping, filling, and sanding are not required at base layer of double-layer applications.

3.8 PROTECTION

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

B. Remove and replace panels that are wet, moisture damaged, and mold damaged.
   1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
   2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

3.9 TOLERANCES

A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

END OF SECTION 092116

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Framing systems.
   2. Suspension systems.
   3. Grid suspension systems.

B. Related Requirements:
   1. Section 054000 "Cold-Formed Metal Framing" for exterior and interior load-bearing and exterior non-load-bearing wall studs; floor joists; and roof rafters and ceiling joists.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:
   1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of code-compliance certification for studs and tracks.

B. Evaluation Reports: For high-strength steel studs and tracks, firestop tracks, post-installed anchors, and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.4 QUALITY ASSURANCE

A. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association, the Steel Framing Industry Association, the Steel Stud Manufacturers Association, or the Supreme Steel Framing System Association.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Notify manufacturer of damaged materials received prior to installation.

B. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

C. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling as required by AISI S202, "Code of Standard Practice for Cold-Formed Steel Structural Framing."

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, in accordance with ASTM E119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, in accordance with ASTM E90 and classified in accordance with ASTM E413 by an independent testing agency.

C. Horizontal Deflection: For wall assemblies, limited to 1/240 of the wall height based on horizontal loading of 5 lbf/sq. ft. (239 Pa).

D. Design framing systems in accordance with AISI S220, "North American Specification for the Design of Cold-Formed Steel Framing - Nonstructural Members," unless otherwise indicated.

E. Design Loads: As indicated on architectural Drawings or 5 lbf/sq. ft. (239 Pa) minimum as required by the NCBC 2018.

2.2 FRAMING SYSTEMS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.

B. Framing Members, General: Comply with AISI S220 for conditions indicated.
   1. Steel Sheet Components: Comply with AISI S220 requirements for metal unless otherwise indicated.
   2. Protective Coating: Comply with AISI S220; ASTM A653/A653M, G40 (Z120); or coating with equivalent corrosion resistance. Galvannealed products are unacceptable.

C. Studs and Track: AISI S220.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. CEMCO; California Expanded Metal Products Co.
      b. ClarkDietrich.
      c. Custom Stud.
      d. Jaimes Industries.
      e. Marino\\WARE.

f. MBA Building Supplies.
g. MRI Steel Framing, LLC.
h. Phillips Manufacturing Co.
i. SCAFCO Steel Stud Company.
j. Steel Construction Systems.
k. Steel Network, Inc. (The).
l. Telling Industries.

2. Minimum Base-Steel Thickness: As required by performance requirements for horizontal deflection.
3. Depth: As indicated on Drawings.

D. Slip-Type Head Joints: Where indicated, provide one of the following:
1. Clip System: Clips designed for use in head-of-wall deflection conditions that provide a positive attachment of studs to tracks while allowing 1-1/2-inch (38-mm) minimum vertical movement.
a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1) CEMCO; California Expanded Metal Products Co.
2) ClarkDietrich.
3) Fire Trak Corp.
4) Marino\\WARE.
5) SCAFCO Steel Stud Company.
6) Steel Construction Systems.
7) Steel Network, Inc. (The).
8) Super Stud Building Products Inc.
2. Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1) CEMCO; California Expanded Metal Products Co.
2) ClarkDietrich.
3) Marino\\WARE.
4) MBA Building Supplies.
5) Metal-Lite.
6) SCAFCO Steel Stud Company.
7) Steel Construction Systems.
8) Steel Network, Inc. (The).
9) Telling Industries.

E. Firestop Tracks: Top track manufactured to allow partition heads to expand and contract with movement of structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. CEMCO; California Expanded Metal Products Co.
b. ClarkDietrich.
c. Fire Trak Corp.
d. Marino\\WARE.
e. Metal-Lite.
f. SCAFCO Steel Stud Company.
g. Steel Construction Systems.
h. Steel Network, Inc. (The).

F. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. ClarkDietrich.
b. Marino\\WARE.
c. MBA Building Supplies.
d. MRI Steel Framing, LLC.
e. SCAFCO Steel Stud Company.
f. Steel Construction Systems.
g. Steel Network, Inc. (The).
2. Minimum Base-Steel Thickness: 0.0296 inch (0.752 mm).

G. Cold-Rolled Channel Bridging: Steel, 0.0538-inch (1.367-mm) minimum base-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. ClarkDietrich.
b. Marino\\WARE.
c. MBA Building Supplies.
d. MRI Steel Framing, LLC.
e. SCAFCO Steel Stud Company.
f. Steel Construction Systems.

H. Hat-Shaped, Rigid Furring Channels:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. ClarkDietrich.
b. Jaimes Industries.
c. Marino\\WARE.
d. MBA Building Supplies.
e. MRI Steel Framing, LLC.
f. SCAFCO Steel Stud Company.
g. Steel Construction Systems.
2. Minimum Base-Steel Thickness: 0.0296 inch (0.752 mm).
3. Depth: As indicated on Drawings.

I. Resilient Furring Channels: 1/2-inch- (13-mm-) deep, steel sheet members designed to reduce sound transmission.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. ClarkDietrich.
      b. Marino\\WARE.
      c. MBA Building Supplies.
      d. MRI Steel Framing, LLC.
      e. SCAFCO Steel Stud Company.
      f. Steel Construction Systems.
   2. Configuration: Asymmetrical or hat shaped.

J. Cold-Rolled Furring Channels: 0.053-inch (1.34-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges.
   1. Depth: As indicated on Drawings.
   2. Furring Brackets: Adjustable, corrugated-edge-type steel sheet with minimum uncoated-steel thickness of 0.0329 inch (0.8 mm).
   3. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.

K. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (32 mm), wall attachment flange of 3/4 inch (19 mm), minimum uncoated-steel thickness of 0.0179 inch (0.455 mm), and depth required to fit insulation thickness indicated.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. ClarkDietrich.
      b. Marino\\WARE.
      c. MBA Building Supplies.
      d. MRI Steel Framing, LLC.
      e. SCAFCO Steel Stud Company.
      f. Steel Construction Systems.
      g. Steel Network, Inc. (The).

2.3 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.

B. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.16 inch (4.12 mm) in diameter.

C. Flat Hangers: Steel sheet, 1 by 3/16 inch (25 by 5 mm) by length indicated.

D. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-steel thickness of 0.0538 inch (1.367 mm) and minimum 1/2-inch- (13-mm-) wide flanges.
   1. Depth: 2-1/2 inches (64 mm).

E. Furring Channels (Furring Members):
1. Cold-Rolled Channels: 0.0538-inch (1.367-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges, 3/4 inch (19 mm) deep.
2. Steel Studs and Tracks:
a. Minimum Base-Steel Thickness: 0.0296 inch (0.752 mm).
b. Depth: As indicated on Drawings.
3. Hat-Shaped, Rigid Furring Channels: 7/8 inch (22 mm) deep.
a. Minimum Base-Steel Thickness: 0.0296 inch (0.752 mm).
4. Resilient Furring Channels: 1/2-inch- (13-mm-) deep members designed to reduce sound transmission.
a. Configuration: Asymmetrical or hat shaped.

2.4 GRID SUSPENSION SYSTEMS

A. Grid Suspension Systems for Gypsum Board Ceilings: ASTM C645, direct-hung system composed of main beams and cross-furring members that interlock.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
a. Armstrong Ceiling & Wall Solutions.
b. Certainteed; SAINT-GOBAIN.
c. Rockfon; ROCKWOOL International.
d. USG Corporation.

2.5 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.
1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Isolation Strip at Exterior Walls: Provide one of the following:
1. Asphalt-Saturated Organic Felt: ASTM D226/D226M, Type I (No. 15 asphalt felt), nonperforated.
2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch (3.2 mm) thick, in width to suit steel stud size.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
   1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

3.3 INSTALLATION, GENERAL

A. Installation Standard: ASTM C754.
   1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C841 that apply to framing installation.
   2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C1063 that apply to framing installation.
   3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C844 that apply to framing installation.
   4. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.

B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.

C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

D. Install bracing at terminations in assemblies.

E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLATION OF FRAMING SYSTEMS

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
   1. Single-Layer Application: 16 inches (406 mm) o.c. unless otherwise indicated.
   2. Multilayer Application: 16 inches (406 mm) o.c. unless otherwise indicated.
   3. Tile Backing Panels: 16 inches (406 mm) o.c. unless otherwise indicated.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.
   1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
   2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.
      a. Install two studs at each jamb unless otherwise indicated.
      b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (13-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.
      c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
   3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
   4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
      a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
   5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
   6. Curved Partitions:
      a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
      b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches (150 mm) o.c.

E. Direct Furring:
   1. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.

F. Z-Shaped Furring Members:
   1. Erect insulation, specified in Section 072100 "Thermal Insulation," vertically and hold in place with Z-shaped furring members spaced 24 inches (610 mm) o.c.
   2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.
   3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches (305 mm) from corner and cut insulation to fit.

G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

3.5 INSTALLATION OF SUSPENSION SYSTEMS

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
   1. Hangers: 48 inches (1219 mm) o.c.
   2. Furring Channels (Furring Members): 16 inches (406 mm) o.c.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:
   1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
      a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
   2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
      a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
   3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
   4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
   5. Do not attach hangers to steel roof deck.
   6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
   7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
   8. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.

3.6 INSTALLATION OF GRID SUSPENSION SYSTEMS

A. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

3.7 FIELD QUALITY CONTROL

A. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 092216

SECTION 092400 - CEMENT PLASTER (STUCCO)

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Portland Cement Plaster Assembly to achieve stucco finish..

1.2 RELATED REQUIREMENTS

A. Section 074213.13 - Metal Composite Material Wall Panels.

B. Section 079200 - Joint Sealants.

1.3 REFERENCE STANDARDS

A. ASTM C926 - Standard Specification for Application of Portland Cement-Based Plaster; 2022b.

B. ASTM C933 - Standard Specification for Welded Wire Lath; 2018.

C. PCA (Portland Cement Association) - Plaster (Stucco) Manual.

D. ICC-ES Acceptance Criteria for Weather-resistive Barriers (AC38).

E. SMA Details and Bulletins.

1.4 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures for submittal procedures.

B. Product Data: All product data sheets, evaluation reports, warranty information..

C. Samples: Two plaster assemblies, 12 by 12 inches in size, indicating color and texture.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing work of the type specified and with at least five years of documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. See Section 017419 - Construction Waste Management and Disposal for packaging waste requirements.

B. Deliver all materials to project site in their original, unopened packaging with labels intact.

C. Inspection: Inspect the materials upon delivery to assure that specified products have been received. Report defects or discrepancies to the responsible party according to the construction documents; do not use reported material for application.

D. Storage: Store all products per manufacturer’s recommendations. Generally, store materials in a cool, dry location; away from direct contact with the ground and/or concrete; out of direct sunlight; and protect from weather and other damage.

1.7 FIELD CONDITIONS

A. Environmental Requirements: Follow product manufacturer's recommendations for environmental conditions and surface preparation.

B. Temperatures: Before, during and following the application of the portland cement plaster, the ambient and surface temperatures must remain above 40 degrees F (4 C) for a minimum period of 24 hours. Protect stucco from uneven and excessive evaporation, especially during hot, dry and/or windy weather. Protect the portland cement plaster from freezing for a period of not less than 24-hours after set has occurred.

C. Substrates: Prior to installation, inspect the wall for surface contamination or other defects that may adversely affect the performance of the materials, and shall be free of residual moisture. Do not apply the portland cement plaster to substrates whose temperature are less than 40 degrees F (4 C) or contain frost or ice.

D. All wood based products covered shall be dry and have a moisture content below 19%. DO NOT COVER WET FRAMING.

E. Inclement Weather: Protect applied material from deleterious effects until cured or dry.

F. Existing Conditions:

G. Contractor shall walk the project prior to starting work and notify the architect or owner’s representative of any deficiencies that will negatively impact the plaster assembly. Do NOT proceed until remedied.

H. Contractor shall advise architect of any horizontal surfaces with inadequate slope.

I. Good Practice: During the rainy season, colored plaster can be damaged if the gutters and downspouts are not in place. It is recommended to have gutters and downspouts installed as soon as possible after plastering is complete.

1.8 WARRANTY

A. See Section 017700 - Closeout Procedures for additional warranty requirements.

B. Finish Warranty: Provide 5-year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking. Complete forms in Owner's name and register with warrantor.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Furnish products produced by single manufacturer and obtained from single supplier.

2.2 SCRATCH AND BROWN COAT

A. Cement: Portland cement complying with ASTM C150.

B. Sand:
1. Field mixes shall comply with ASTM C-926 and must have sand that is clean and free from deleterious amounts of loam, clay, silt, soluble salts and organic matter. Sampling and testing shall comply with ASTM C144 or C897.
2. Sand may be an “engineered performance mix” by an SMA manufacturer. Submit appropriaate approvals (ICC ES, IAPMO or Interek report.

2.3 WATER-RESISTIVE BARRIER

A. Over Open Framing and non-wood based sheathing:
1. One layer of aphalt-saturated felt complying with ASTM D226 Type 1.

B. Over wood based sheathing:
1. SMA approved fluid applied WRB and one layer D paper, felt or equivalent.

2.4 LATH

A. Woven-Wire Lath: Self-furring Nominal No. 17 gauge (0.058 inch), 1.5-inch opening, galvanized steel complying with ASTM C1032.

2.5 PRIMER

A. As recommended by manufacturer.

2.6 MIXES

A. Basecoat: Contractor shall select one of the following mixes (sand is per combined volume of cements):
   1. Mix 1 -.
      a. Portland Cement 1 part.
      b. Masonry Cement 1 part.
      c. Sand 3 ½ to 4 ½ parts per Cement.
      d. Fibers Maximum 3 oz per batch.
   2. Mix 2 -.
      a. Portland Cement 1 part.
      b. Lime (type S) ¼ to ½ part.
      c. Sand 3 to 4 parts per cement & Lime.
      d. Fibers Maximum 3 oz per batch.
   3. Mix 3 -.
      a. Plastic Cement 1 part.
      b. Sand 3 ½ to 4 ½ parts per cement.
      c. Fibers Maximum 3 oz per bag plastic cement.
   4. Pre-engineered mix provided by manufacturer.

B. Finish Coat: In accordance with manufacturer's instructions.
   1. Finish: Portland cement-based blended stucco.
   2. Color and texture: As selected by Architect.

2.7 ACCESSORIES

A. Sealants: As recommended by manufacturer.

B. Fasteners: Nails, staples, or screws used to rigidly secure lath and associated accessories shall be corrosion-resistant and meet the minimum requirements of ASTM C1063.

C. Plastic Trim: Fabricated from high-impact PVC.

D. Cornerbeads: With perforated flanges. Bull nose style; use unless otherwise indicated.

E. Casing Beads: With perforated flanges in depth required to suit plaster bases indicated and flange length required to suit applications indicated.

F. Control Joints: One-piece-type, folded pair of unperforated screeds in configuration as shown on Drawings; removable protective tape on plaster face of control joint.

G. Expansion Joints: Two-piece-type formed to produce a slip-joint.

H. Z-channel furring: 20-guage minimum to support board insulation.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Verify:
   1. Grounds and Blocking: Verify that the items within the walls for other sections of work have been installed.
   2. Substrates:
      a. Acceptable substrates must be sound, secure and suitable for lath and plaster.
      b. Substrates and adjacent materials must be dry and clean. Substrate surface must be flat, free of protrusions or planar irregularities greater than ¼-nch in 10-feet (6mm in 3m).
   3. Flashings: All flashing around windows, at deck attachments, utility penetrations, roof lines, etc. and all kick-out flashing must be properly installed prior to application of portland cement plaster. Notify owner if flashings are missing, proceed as directed.

3.2 INSTALLATION

A. Install in accordance with manufacturer's written instructions.

B. Fog coat as needed to blend color variations.

3.3 CLEANING

A. Remove any and all materials used, overspray from adjacent surfaces, and all protective masking.

B. Patch and repair as needed, including but not limited to fog coating, imperfections and blisters.

3.4 PROTECTION

A. Protect applied material from inclement weather until dry and prevent it from freezing for a minimum of 24-hours after set and/or until dry. Refer to manufacturer’s product data sheet for additional requirements.

END OF SECTION 092400

SECTION 092900 - GYPSUM BOARD

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Interior gypsum board.
2. Exterior gypsum board for ceilings and soffits.
3. Tile backing panels.
4. Metal Edge Strips.
5. Metal Base.

B. Related Requirements:
1. Section 061600 "Sheathing" for gypsum sheathing for exterior walls.
2. Section 092216 "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.
3. Section 134900 X-Ray Protection.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For the following products:
1. Trim Accessories: Full-size Sample in 12-inch- long length for each trima accessory indicated.
2. Textured Finishes: Manufacturer's standard size for each textured finish indicated and on same backing indicated for Work.

C. Samples for Initial Selection: For each type of trim accessory indicated.

D. Samples for Verification: For the following products:
1. Trim Accessories: Full-size Sample in 12-inch- long length for each trim accessory indicated.
2. Textured Finishes: Manufacturer's standard size for each textured finish indicated and on same backing indicated for Work.

1.4 QUALITY ASSURANCE

A. Mockups: Build mockups of at least 100 sq. ft. in surface area to demonstrate aesthetic effects and to set quality standards for materials and execution.
   1. Build mockups for the following:
      a. Each level of gypsum board finish indicated for use in exposed locations.
      b. Each texture finish indicated.
   2. Apply or install final decoration indicated, including painting and wallcoverings, on exposed surfaces for review of mockups.
   3. Simulate finished lighting conditions for review of mockups.
   4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Final Acceptance.

1.5 DELIVERY, STORAGE AND HANDLING

A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.

B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, moisture damaged, and mold damaged.
   1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
   2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

A. Gypsum Ceiling Board: ASTM C 1396/C 1396M.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Gypsum.
      b. CertainTeed Corporation.
      c. Georgia-Pacific Gypsum LLC.
      d. National Gypsum Company.
      e. USG Corporation.
   2. Thickness: 1/2 inch.
   3. Long Edges: Tapered.

B. Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Gypsum.
      b. CertainTeed Corporation.
      c. Georgia-Pacific Gypsum LLC.
      d. National Gypsum Company.
      e. USG Corporation.
   2. Core: 5/8 inch, Type X.
   3. Long Edges: Tapered.
   4. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.4 INTERIOR GYPSUM BOARD

A. Glass-Mat Gypsum Sheathing Board: ASTM C 1177/C 1177M, with fiberglass mat laminated to both sides and with manufacturer's standard edges.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Gypsum.
      b. CertainTeed Corporation.
      c. Georgia-Pacific Gypsum LLC.
      d. National Gypsum Company.
      e. USG Corporation.
   2. Core: 5/8 inch, Type X.

2.5 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.
   1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
   2. Shapes:
      a. Cornerbead.
      b. LC-Bead: J-shaped; exposed long flange receives joint compound.
      c. L-Bead: L-shaped; exposed long flange receives joint compound.
      d. U-Bead: J-shaped; exposed short flange does not receive joint compound.
      e. Expansion (control) joint.
      f. Curved-Edge Cornerbead: With notched or flexible flanges.

B. Aluminum Trim: Extruded accessories of profiles and dimensions indicated. See Section 102600 - “Wall and door protection” for corner details.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Flannery, Inc.
      b. Fry Reglet Corporation.
      c. Gordon, Inc.
      d. Pittcon Industries.
   2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221, Alloy 6063-T5.

2.6 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:
   1. Interior Gypsum Board: Paper.
   2. Exterior Gypsum Soffit Board: Paper.
   3. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
   4. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
   1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
   2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
      a. Use setting-type compound for installing paper-faced metal trim accessories.
   3. Fill Coat: For second coat, use setting-type, sandable topping compound.
   4. Finish Coat: For third coat, use drying-type, all-purpose compound.
   5. Skim Coat: For final coat of Level 5 finish, use high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish.

D. Joint Compound for Exterior Applications:
   1. Exterior Gypsum Soffit Board: Use setting-type taping compound and setting-type, sandable topping compound.
   2. Glass-Mat Gypsum Sheathing Board: As recommended by sheathing board manufacturer.

2.7 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.

B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

C. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.
   1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
   2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

D. Sound-Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

E. Acoustical Sealant: Manufacturer's standard non-sag, paintable, non-staining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Accumetric LLC.
      b. Everkem Diversified Products, Inc.
      c. Franklin International.
      d. Grabber Construction Products.
      e. Hilti, Inc.
      f. Pecora Corporation.
      g. Specified Technologies, Inc.
      h. USG Corporation.

F. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."

2.8 MISCELLANEOUS MATERIALS

A. 092900.G METAL REVEAL BASE.
   1. Basis of Design: Fry Reglet, WCTBT125-217.
      a. Factory formed metal edge to be installed during gypsum installation in the set bed for full integration with wall system.
      b. Finish: Buffed Satin Brass.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL

A. Comply with ASTM C 840.

B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.

D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

E. Form control and expansion joints with space between edges of adjoining gypsum panels.

F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
   1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
   2. Fit gypsum panels around ducts, pipes, and conduits.
   3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.

G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

I. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

J. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 APPLYING INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:
   1. Ceiling Type: Ceiling surfaces.
   2. Mold-Resistant Type:
      a. The following rooms:
         1) All restroom wet walls.

B. Single-Layer Application:
   1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
   2. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
      a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
      b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
   3. On Z-shaped furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
   4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

C. Multilayer Application:
   1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
   2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
   3. On Z-shaped furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
   4. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

D. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written instructions and temporarily brace or fasten gypsum panels until fastening adhesive has set.

3.4 APPLYING EXTERIOR GYPSUM PANELS FOR CEILINGS AND SOFFITS

A. Apply panels perpendicular to supports, with end joints staggered and located over supports.
   1. Install with 1/4-inch open space where panels abut other construction or structural penetrations.
   2. Fasten with corrosion-resistant screws.

3.5 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.

C. Interior Trim: Install in the following locations:
   1. Cornerbead: Use at outside corners unless otherwise indicated.
   2. LC-Bead: Use at exposed panel edges.
   3. L-Bead: Use where indicated.
   4. U-Bead: Use at exposed panel edges where indicated.

D. Exterior Trim: Install in the following locations:
   1. Cornerbead: Use at outside corners.
   2. LC-Bead: Use at exposed panel edges.

E. Aluminum Trim: Install in locations indicated on Drawings.

3.6 FINISHING GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints and damaged surface areas.

C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
   1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.

2. Level 2: Panels that are substrate for tile; Panels that are substrate for acoustical tile and where indicated on Drawings.
3. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
    a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."
4. Level 5: Where indicated on Drawings and as follows:
    a. All spaces (walls and ceilings) where exposed to view.
    b. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."

E. Glass-Mat Gypsum Sheathing Board: Finish according to manufacturer's written instructions for use as exposed soffit board.

F. Glass-Mat Faced Panels: Finish according to manufacturer's written instructions.

G. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.7 PROTECTION

A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
1. Indications that panels are wet, or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900

SECTION 093013 - CERAMIC TILING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Porcelain tile.
2. Ceramic mosaic tile.
3. Waterproof membranes.
4. Crack isolation membranes.
5. Setting material.
6. Grout materials.

B. Related Requirements:
1. Section 079200 "Joint Sealants" for sealing of movement joints in tile surfaces.
2. Section 092900 "Gypsum Board" for tile backing panels.

1.2 DEFINITIONS

A. General: Definitions in ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.

B. Face Size: Actual tile size, excluding spacer lugs.

C. Large Format Tile: Tile with at least one edge 15 inches (381 mm) or longer.

D. Module Size: Actual tile size plus joint width indicated.

E. Refer to ANSI guides published 2017 - 2023. Refer to TCNA guides published 2022 - 2023.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Tile.
2. Gauged Porcelain Panels.
3. Tile backing panels.
4. Waterproof membranes.
5. Crack isolation membranes.
6. Setting material.
7. Grout materials.

B. Shop Drawings: Show locations, plans, and elevations, of each type of tile and tile pattern. Show widths, details, and locations of movement joints in tile substrates and finished tile surfaces. Show thresholds.

C. Samples for Verification:
   1. Full-size units of each type and composition of tile and for each color and finish required. For ceramic mosaic tile in color blend patterns, provide full sheets of each color blend.
   2. Full-size units of each type of trim and accessory for each color and finish required.
   3. Metal flooring transitions 6-inch (152-mm) lengths.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of product, including product use classification.

C. Product Test Reports:
   1. Tile-setting and -grouting products.

D. Field Quality-Control Reports: Water test reports of membrane in wet areas.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials, from the same production run, to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Tile and Trim Units: Furnish quantity of full-size units equal to 5 percent of amount installed for each type, composition, color, pattern, and size indicated.
   2. Grout: Furnish quantity of grout equal to 5 percent of amount installed for each type, composition, and color indicated.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Installer is a Five-Star member of the National Tile Contractors Association or a Trowel of Excellence member of the Tile Contractors' Association of America.
   2. Installer employs at least one installer for Project that has completed the Advanced Certification for Tile Installers (ACT) certification for installation of Gauged Porcelain Panels and Gauged Porcelain Tile Panels/ Slabs.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.

B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.

C. Store aggregates where grading and other required characteristics can be maintained, and contamination can be avoided.

D. Store liquid materials in unopened containers and protected from freezing.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

1.9 WARRANTY

A. System Warranty: Manufacturer's non-prorated comprehensive warranty that agrees to repair and replace defective installation areas, material, and labor that fail under normal usage within specified warranty period.
   1. Warranty Period: As specified by manufacturer from date of Product Purchase.

PART 2 PRODUCTS

2.1 SOURCE LIMITATIONS

A. Tile: Obtain tile of each type and color or finish from single source or producer.
   1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.

B. Tiling System: Obtain system products from single manufacturer and each aggregate from single source or producer.

C. Accessory Products: Obtain each of the following products specified in this Section from a single manufacturer:

2.2 PRODUCTS, GENERAL

A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
   1. Provide tile complying with Standard Grade requirements unless otherwise indicated.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

2.3 TILE

A. Floor Tile (TL-).
   1. Manufacturers: Subject to compliance with requirements, provide Basis of Design product or comparable product indicated on drawings.

B. Wall Tile (TL-).
   1. Manufacturers: Subject to compliance with requirements, provide Basis of Design product or comparable product indicated on drawings.

2.4 WATERPROOF MEMBRANES

A. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.10 and ANSI A118.12 and is recommended by manufacturer for application indicated. Include reinforcement and accessories recommended by manufacturer.

B. Waterproof Membrane, Fluid Applied: Liquid-latex rubber or elastomeric polymer with continuous fabric reinforcement.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Custom Building Products.
      b. Laticrete International, Inc.
      c. MAPEI Corporation.

2.5 CRACK ISOLATION MEMBRANES

A. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.12 for high performance and is recommended by manufacturer for application indicated. Include reinforcement and accessories recommended by manufacturer.

B. Crack Isolation Membrane: For use in thin-set ceramic tile installations.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Custom Building Products.
      b. Laticrete International, Inc.
      c. MAPEI Corporation.

2.6 SETTING MATERIALS

A. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.02.
   1. Reinforcing Wire Fabric: Galvanized, welded-wire fabric, 2 by 2 inches (50.8 by 50.8 mm) by 0.062-inch (1.57-mm) diameter; comply with ASTM A1064/A1064M except for minimum wire size.

B. Improved Modified Dry-Set Mortar (Thinset): ANSI A118.15.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Custom Building Products.
b. Laticrete International, Inc.
c. MAPEI Corporation.

2. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
3. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to other requirements in ANSI A118.15.

2.7 GROUT MATERIALS

A. High-Performance Tile Grout: ANSI A118.7.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Custom Building Products.
      b. Laticrete International, Inc.
      c. MAPEI Corporation.

B. Water-Cleanable Epoxy Grout: ANSI A118.3, with a VOC content of 65 g/L or less.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Custom Building Products.
      b. Laticrete International, Inc.
      c. MAPEI Corporation.
   2. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 and 212 deg F (60 and 100 deg C), respectively, and certified by manufacturer for intended use.

2.8 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting and adhesive materials for installations indicated.

B. Extruded Foam Board: Rigid extruded polystyrene foam building element panel, with reinforcement material and polypropylene fleece webbing laminated on both sides for thin-set ceramic tile.

C. Metal Flooring Transitions (093013.A): Profile designed specifically for flooring applications; height to match tile and setting-bed thickness.
   1. Manufacturers: Subject to compliance with requirements, provide product indicated by Schluter Systems, or by on the of following comparable products:
      a. Blanke Corporation.
      b. Custom Building Products.
   2. Description: Reno-Ramp/-K at uneven floor transitions; Deco at level floor transitions.
   3. Material and Finish: Metallic or combination of metal and PVC or neoprene base; polished nickel anodized aluminum exposed-edge material.
      a. Color: Brushed Graphite Anodized Aluminum AGRB.

D. Metal Edge Trim (093013.A): Profile designed for wall terminations and edge protection.
   1. Manufacturers: Subject to compliance with requirements, provide product indicated below by Schluter Systems, or by one of the following comparable products: provide products by one of the following:
      a. Blanke Corporation.
      b. Custom Building Products.
   2. Description: L-shaped Jolly.
   3. Terminations: End caps Outside corners matching edge-protection profile.
   4. Material and Finish: Polished nickel anodized aluminum exposed-edge material.
      a. Color: Satin Anodized.

E. Metal Edge Trim (093013.A): Profile designed for wall terminations and edge protection.
   1. Manufacturers: Subject to compliance with requirements, provide product indicated below by Schluter Systems, or by one of the following comparable products: provide products by one of the following:
      a. Blanke Corporation.
      b. Custom Building Products.
   2. Description: Finec.
   3. Terminations: End caps Outside corners matching edge-protection profile.
   4. Material and Finish: Polished nickel anodized aluminum exposed-edge material.
      a. Color: Satin Anodized.

F. Metal Corner Shelf (093013.A): Profile designed to be at shower tile applications.
   1. Manufacturers: Basis of Design: Subject to compliance with requirements, provide product indicated below by Schluter Systems, or by one of the following comparable products:
      a. Blanke Corporation.
      b. Custom Building Products.
   2. Description: Shelf-E, Wave.
   3. Terminations: Factory formed metal shelf to be installed during tile installation in this set bed for full integration with tile system. Edge shelf to align with grout lines.
   4. Material and Finish: Polished nickel anodized aluminum exposed-edge material.
      a. Color: Brushed Stainless Steel.

G. Temporary Protective Coating: Formulated to protect exposed surfaces of tile against adherence of mortar and grout; compatible with tile, mortar, and grout products and easily removable after grouting is completed without damaging grout or tile.

H. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

I. Grout Sealer: Grout manufacturer's standard product for sealing grout joints that does not change color or appearance of grout.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
   2. Verify that concrete substrates for tile floors installed with bonded mortar bed comply with surface finish requirements in ANSI A108.01 for installations indicated.
      a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
      b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
   3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
   4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove coatings, including curing compounds or other coatings, that are incompatible with tile-setting materials.

B. Where indicated, prepare substrates to receive waterproof membrane by applying a reinforced mortar bed that complies with ANSI A108.1 and is sloped 1/4 inch per foot (1:50) toward drains.

C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

D. Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during installation.

E. Substrate Flatness:
   1. For tile shorter than 15 inches (381 mm), confirm that structure or substrate is limited to variation of 1/4 inch in 10 ft. (6.4 mm in 3 m) from the required plane, and no more than 1/16 inch in 12 inches (1.5 mm in 300 mm) when measured from tile surface high points.
   2. For large format tile, tile with at least one edge 15 inches (381 mm) or longer, confirm that structure or substrate is limited to 1/8 inch in 10 ft. (3 mm in 3 m) from the required plane, and no more than 1/16 inch in 24 inches (1.5 mm in 609 mm) when measured from

tile surface high points.

3.3 INSTALLATION OF CERAMIC TILE SYSTEM

A. Install tile backing panels and treat joints in accordance with ANSI A108.11 and manufacturer's written instructions for type of application indicated.

B. Install waterproof membrane to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate. Waterproof membrane is to extend from floor to ceiling in vertical installations.
   1. Allow waterproof membrane to cure and verify by testing that it is watertight before installing tile or setting materials over it.

C. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.
   1. Allow crack isolation membrane to cure before installing tile or setting materials over it.

D. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
   1. Add materials, water, and additives in accurate proportions.
   2. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

E. Install tile in accordance with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of ANSI A108 series that are referenced in TCNA installation methods and specified in tile installation schedules, and apply to types of setting and grouting materials used.
   1. For the following installations, follow procedures in ANSI A108 series of tile installation standards for providing 95 percent mortar coverage in all applications.
   2. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
   3. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
   4. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
      a. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets, so joints between sheets are not apparent in finished Work.
      b. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
      c. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.

5. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.

F. Movement Joints: Provide movement joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated on Drawings. Form joints during installation of setting materials, mortar beds, and tile. Keep joints free of dirt, debris, and setting materials prior to filling with sealants. Do not saw-cut joints after installing tiles.
   1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.

G. Metal Flooring Transitions: Install where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with or below top of tile and no threshold is indicated.

H. Metal Wall Trim: Install at locations indicated on Drawings.

I. Grout Sealer: Apply grout sealer to cementitious grout joints in accordance with manufacturer's written instructions. As soon as sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.4 FIELD QUALITY CONTROL

A. Water Test:
   1. Test of waterproofing membrane in showers and similar areas to be performed by Installation Contractor before setting tile.
      a. Perform test after 24 hours of waterproof membrane installation.
      b. Insert test plug in drain or waste line.
      c. Fill shower base with water, high enough that the membrane-to-drain connection and floor-to-wall transition can be evaluated, and mark wall.
      d. Check for leaks after 24 hours.
   2. Test to be witnessed by Architect.

B. Nonconforming Work:
   1. Waterproof membrane will be considered defective if water level has dropped.
   2. Remove and replace defective components and retest.

3.5 ADJUSTING AND CLEANING

A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.

B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
   1. Remove grout residue from tile as soon as possible.
   2. Clean grout smears and haze from tile in accordance with tile and grout manufacturer's written instructions. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3.6 PROTECTION

A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.

B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.

C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

D. Provide Ram Board or equal for all flooring once installed until beneficial occupancy.

3.7 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

A. Shower, Concrete Subfloor:
   1. TCNA B421-22 Cement mortar bed (thickset) installed over waterproof membrane.
      a. Tile Type: See Drawings.
      b. Waterproof membrane: Fluid-applied membrane.
      c. Mortar Bed: Bonded.
      d. Cementitious Bond Coat: Improved modified dry-set mortar.
      e. Grout: Water-cleaneable epoxy grout.
      f. Flexible sealant.
      g. Joint Width: See Drawings.

B. Interior Wall Installations, Wood or Metal Studs or Furring:
   1. TCNA W244C-22 : Bond coat over cement backer board.
      a. Tile Type: See Drawings.
      b. Cementitious Bond Coat: Improved modified dry-set mortar.
      c. Waterproof Membrane: Fluid-applied membrane.
      d. Grout: High-performance cement grout.
      e. Joint Width: See Drawings.

C. Bathtub/ Shower Wall Installations:
   1. TCNA B422-22: Thinset mortar over waterproof membrane on coated glass-mat, water-resistant gypsum backer board.
      a. Ceramic Tile Type: See finish legend.
      b. Thinset Mortar: Polymer - Modifiedmortar.
      c. Grout: Water-cleanable epoxy grout.
      d. Waterproof Membrane: As recommended by setting material manufacturer.
      e. Joint Width: 1/8 inch (3.2 mm).
      f. Movement Joints: To be located on shop drawings.

END OF SECTION 093013

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 GENERAL

1.1 SUMMARY

1.2 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.3 SUMMARY

A. Section Includes:
   1. Acoustical panels.
   2. Metal suspension system.
   3. Provisions for the installation of lighting fixtures, diffusers, grilles and similar items provided under other Sections.
   4. Cutting, drilling, scribing and fitting as required for electro-mechanical penetrations.
   5. Perimeter and column moldings, trim and accessories for acoustical ceilings.

B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.4 ACTION SUBMITTALS

A. Product Data:
   1. Acoustical panels.
   2. Metal edge moldings and trim.

B. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of sizes indicated below:
   1. Acoustical Panels: Set of 6-inch- (150-mm-) square Samples of each type, color, pattern, and texture.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Ceiling suspension-system members.
   2. Structural members to which suspension systems will be attached.
   3. Method of attaching hangers to building structure.
   4. Carrying channels or other supplemental support for hanger-wire attachment where

conditions do not permit installation of hanger wires at required spacing.
5. Size and location of initial access modules for acoustical panels.
6. Items penetrating finished ceiling and ceiling-mounted items including the following:
   a. Lighting fixtures.
   b. Diffusers.
   c. Grilles.
   d. Speakers.
   e. Sprinklers.
   f. Access panels.
   g. Perimeter moldings.
7. Minimum Drawing Scale: 1/8 inch = 1 foot (1:96).

B. Qualification Data: For testing agency.

C. Product Test Reports: For each acoustical panel ceiling, for tests performed by a qualified testing agency.

D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same production run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Acoustical Ceiling Units: Full-size panels equal to 5 percent of quantity installed.
   2. Suspension-System Components: Quantity of each exposed component equal to 5 percent of quantity installed.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical panels, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
   1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

PART 2 PRODUCTS

2.1 SOURCE LIMITATIONS

A. Source Limitations for Ceiling System: Obtain each type of acoustical ceiling panel and its supporting suspension system from single source from single manufacturer.

2.2 ACOUSTICAL PANEL CEILINGS & METAL SUSPENSION SYSTEMS

A. Acoustical Panels (APC-):
   1. Manufacturers: Subject to compliance with requirements, provide Basis of Design product or comparable product indicated on drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.

B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.

B. Layout openings for penetrations centered on the penetrating items.

3.3 INSTALLATION OF ACOUSTICAL PANEL CEILINGS

A. Install acoustical panel ceilings in accordance with ASTM C636/C636M, seismic design requirements, and manufacturer's written instructions.

B. Suspend ceiling hangers from building's structural members and as follows:
   1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
   2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
   3. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly to structure or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
   4. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
   5. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
   6. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
   7. Do not attach hangers to steel deck tabs.
   8. Do not attach hangers to steel roof deck. Attach hangers to structural members.
   9. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.
   10. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or post-installed anchors.

D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
   1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
   2. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends. Miter corners accurately and connect securely.
   3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension-system runners so they are square and securely interlocked with one

another. Remove and replace dented, bent, or kinked members.

F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide precise fit.
   1. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.

3.4 ERECTION TOLERANCES

A. Suspended Ceilings: Install main and cross runners level to a tolerance of 1/8 inch in 12 feet (3 mm in 3.6 m), non-cumulative.

B. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3 mm in 3.6 m), non-cumulative.

3.5 CLEANING

A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.

B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Rubber Vinyl base.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified, not less than 3 inches (300 mm) long.

C. Product Schedule: For resilient base and accessory products. Use same designations indicated on Drawings.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Furnish not less than 5% or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C).

1.6 FIELD CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 85 deg F, in spaces to receive resilient products during the following periods:
   1. 48 hours before installation.
   2. During installation.
   3. 48 hours after installation.

B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).

C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 PRODUCTS

2.1 RUBBER VINYL BASE (RB-)

A. Manufacturers:Subject to compliance with requirements, provide Basis of Design product or comparable product indicated on drawings.

B. Product Standard: ASTM F 1861, Type I (Rubber).
   1. Style and Location:
      a. Style A, Straight: See finish schedule.

C. Minimum Thickness: 0.125 inch (3.2 mm).

D. Height: As indicated on Drawings.

E. Lengths:Coils in manufacturer's standard length.

F. Outside Corners: Job formed.

G. Inside Corners: Job formed.

H. Colors and Patterns: As indicated on drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
   1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

B. Proceed with installation only after unsatisfactory conditions have been corrected.
   1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

C. Do not install resilient products until materials are the same temperature as space where they are to be installed.
   1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.

D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

G. Job-Formed Corners:
   1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches (76 mm) in length.
      a. Form without producing discoloration (whitening) at bends.
   2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches (76 mm) in length.
      a. Miter corners to minimize open joints.

3.4 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.

B. Perform the following operations immediately after completing resilient-product installation:
   1. Remove adhesive and other blemishes from surfaces.
   2. Sweep and vacuum horizontal surfaces thoroughly.
   3. Damp-mop horizontal surfaces to remove marks and soil.

C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 096513

SECTION 096516 - RESILIENT SHEET FLOORING

PART 1 GENERAL

1.1 SUMMARY

A. Work Results:

B. Principal Products:

1.2 RELATED SECTIONS

A. Cast-in-Place Concrete - Section 033000.

B. Gypsum Drywall - Section 092900.

1.3 QUALITY ASSURANCE

A. Qualifications of Installers: Use only personnel who are thoroughly trained and experienced in the skills required and completely familiar with the requirements established for this work.

B. Surface Burning Characteristics: Class 1 when tested in accordance with ASTM E 648/NFPA 253, Standard Test Method for Critical Radiant Flux. Meets 450 or less when tested in accordance with ASTM E 662/ NFPA 258, Standard Test Method for Smoke Density.

1.4 SUBMITTALS

A. Manufacturer's Data: For information only, submit manufacturer's technical information and installation instructions for type of resilient sheet flooring required.

B. Samples: Submit samples of each color of resilient sheet flooring required. Provide twelve (12) inch square samples to illustrate the range of color and pattern variation. Sample submittals will be reviewed for color, texture and pattern only. Compliance with all other requirements is the exclusive responsibility of the Contractor.

C. Maintenance Instructions: Submit two (2) copies of manufacturer's written instructions for recommended maintenance practices for each type of resilient sheet flooring.

1.5 DELIVERY AND STORAGE

A. Deliver materials to the project site in the manufacturer's original unopened containers, clearly marked to indicate pattern, gauge, lot number and sequence of materials.

B. Carefully handle all materials and store in original containers at not less than seventy (70) degrees F. for at least forty-eight (48) hours before start of installation.

1.6 JOB CONDITIONS

A. Continuously heat spaces to receive tile to a temperature of seventy (70) degrees F. for at least forty-eight (48) hours prior to installation, whenever project conditions are such that heating is required. Maintain seventy (70) degrees F. temperature continuously during and after installation as recommended by the tile manufacturer, but for not less than forty-eight (48) hours. Maintain a temperature of not less than fifty-five (55) degrees F. in areas where work is completed.

PART 2 PRODUCTS

2.1 LINOLEUM SHEET FLOORING (RSF-)

A. Basis of Design: 0.137" thick homogeneous linoleum sheet flooring of primarily natural materials consisting of linseed oil, wood flour, rosin binders, limestone and dry pigments mixed and calendered onto natural jute backing, in seventy-nine (79) inch wide rolls. Flame spread seventy-five (75) or less. Provide "Marmoleum Real" as manufactured by Forbo, or equivalent product of Armstrong, Johnsonite, or approved equal. Meets or exceeds all technical requirements as set forth in ASTM F 2034, Standard Specification for Linoleum Sheet Floor Covering, Type III.
   1. Colors: 3139 Lava or 3137 Slate Grey.

2.2 ACCESSORIES

A. Adhesives: Waterproof, stabilized type, as recommended by the manufacturer for the type of service indicated. Forbo Eurocol 614 Eurostar Lino Plus.

B. Heat Welding Rod: Color matched welding rod.

C. Leveling Compound: Latex/Portland cement flash patching and leveling compound equal to No. 226 with 3701 admixture made by Laticrete or equal made by Mapei, H.B. Fuller or approved equal.

D. Concrete Slab Primer: Non-staining type as recommended by the sheet flooring manufacturer.

E. Finish: Per manufacturer.

F. Floor Cleaner: Per manufacturer.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where linoleum sheet flooring is to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 PREPARATION

A. Subfloors: Prior to start of laying the sheet flooring, broom clean or vacuum all surfaces to be covered.
   1. Lightly grind concrete subfloors with a terrazzo grinder to remove any trowel marks or other surface irregularities which will telegraph to the sheet flooring surface. If grinding is not required, acid etch floor with ten (10) percent muriatic acid as required to remove any curing compound that would interfere with adhesive bond.
   2. Use leveling compound as recommended by sheet flooring manufacturer for filling small cracks and depressions in subfloors and generally level the floor.
   3. Subfloor shall be level to ±1/8" in 10'-0" distance and 1/4" total maximum variation from level shown.
   4. Perform moisture tests on concrete slabs to determine that concrete surfaces are sufficiently cured and are ready to receive flooring installation.

B. Concrete Primer: Apply concrete slab primer if recommended by the sheet flooring manufacturer, prior to application of the adhesive. Apply in compliance with manufacturer's directions.

3.3 INSTALLATION

A. Install sheet flooring only after all finishing operations, including painting, have been completed and permanent heating system is operating. Moisture content of concrete slabs, building air temperature and relative humidity must be within limits recommended by sheet flooring manufacturer.

B. Flooring shall be installed to a tolerance of 1/8" in 10'-0" run; 1/32" offset at any location.

C. Place sheet flooring with adhesive cement in strict compliance with the manufacturer's recommendations. Butt tightly to vertical surfaces, thresholds, nosings and edgings. Scribe around obstructions and to produce neat joints, laid tight, even and in straight, parallel lines. Extend sheet flooring into toe spaces, door reveals, and into closet and similar openings.

D. Provide integral cove base where scheduled, including cove support strip and aluminum top edge strip. Construct coved base in accordance the manufacturer's instructions.

E. Maintain reference markers, holes, or openings that are in place or plainly marked for future cutting by repeating on the finish flooring as marked in the subfloor. Use chalk or other non-

permanent marking devices.

F. Lay sheet flooring to substrate without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, or other surface imperfections.

G. Lay sheet flooring to provide as few seams as possible. Match edges for color shading and pattern at seams in compliance with the manufacturer's recommendations, such as reversing adjoining sheets of the same roll, so that abutting edges are from the same edge of the roll.

H. Weld seams in linoleum sheet flooring in compliance with the manufacturer's instructions to provide a "seamless" installation.

I. Place resilient edge strips tightly butted to sheet flooring and secure with adhesive. Provide edging strips at all unprotected edges of sheet flooring, unless otherwise shown.

3.4 CLEANING AND PROTECTION

A. Remove any excess adhesive or other surface blemishes from sheet flooring, using neutral type cleaners as recommended by the sheet flooring manufacturer. Protect installed flooring from damage by use of heavy Kraft paper or other covering.

B. Finishing: After completion of the project and just prior to the final inspection of the work, thoroughly clean tile floors and accessories. Finish as recommended by manufacturer.

END OF SECTION 096516

SECTION 096519 - RESILIENT TILE FLOORING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Resilient Tile Flooring.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Verification: Full-size units of each color and pattern of floor tile required.

C. Product Schedule: For floor tile. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of floor tile to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Floor Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for floor tile installation and seaming method indicated.
   1. Engage an installer who employs workers for this Project who are trained or certified by floor tile manufacturer for installation techniques required.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C). Store floor tiles on flat surfaces.

1.9 FIELD CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive floor tile during the following periods:
   1. 48 hours before installation.
   2. During installation.
   3. 48 hours after installation.

B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).

C. Close spaces to traffic during floor tile installation.

D. Close spaces to traffic for 48 hours after floor tile installation.

E. Install floor tile after other finishing operations, including painting, have been completed.

PART 2 PRODUCTS

2.1 RESILIENT TILE FLOORING (RTF-)

A. Products: Subject to compliance with requirements, provide Basis of Design product or comparable product indicated on drawings:

2.2 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
   1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.

B. Concrete Substrates: Prepare according to ASTM F 710.
   1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
   2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.
   3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
      a. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
      b. Relative Humidity Test: Using in-situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum per manufacturer's instructions. Percent relative humidity level measurement.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install floor tiles until materials are the same temperature as space where they are to be installed.
   1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.

E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

3.3 FLOOR TILE INSTALLATION

A. Comply with manufacturer's written instructions for installing floor tile.

B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
   1. Lay tiles as indicated in Drawings.

C. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.

D. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.

E. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.

F. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.

G. Adhere floor tiles to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.4 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting floor tile.

B. Perform the following operations immediately after completing floor tile installation:
   1. Remove adhesive and other blemishes from surfaces.
   2. Sweep and vacuum surfaces thoroughly.
   3. Damp-mop surfaces to remove marks and soil.

C. Protect floor tile from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during the remainder of construction period.

D. Add Ram board to protect flooring until beneficial occupancy.

END OF SECTION 096519

SECTION 096623 - EPOXY-RESIN TERRAZZO FLOORING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes.
   1. Thin-set epoxy terrazzo.
   2. Cast stair nosing.
   3. Related accessories.

B. Related Requirements:
   1. Section 033000, Cast In Place Concrete.
   2. Section 057313, Glazed Decorative Railings.
   3. Section 072616, Under-slab Vapor Retarder/Barrier.
   4. Section 079000, Joint Protection.

1.2 REFERENCES

A. The National Terrazzo & Mosaic Association Inc. (NTMA):
   1. “Terrazzo Specifications and Design Guide”.
   2. “Guide Specification for Epoxy Terrazzo”.
   3. Technical Bulletin #111.

1.3 COORDINATION

A. Coordinate the types of traffic allowed on terrazzo between the following events:
   1. Completion of pouring and before coarse grinding.
   2. Completion of grouting and before polishing.

B. Coordinate the preparation for terrazzo work with the installation of plumbing, electrical, communications, and data work in the floor area to receive terrazzo.
   1. Verify that fixtures, equipment, and outlets will be located properly and at the correct elevation.

1.4 PREINSTALLATION MEETINGS

A. Pre-installation Conference: Prior to installation of concrete substrates, conduct meeting at project site. Review methods and procedures related to terrazzo including, but not limited to, the following:
   1. Inspect and discuss installation procedures, joint details, jobsite conditions, substrate specification, vapor barrier details and coordination with other trades.
   2. Review and finalize construction schedule and verify availability of materials, Installer’s personnel, equipment and facilities needed to make progress and avoid delays.

3. Review special terrazzo designs and patterns.
4. Review dust control procedures.
5. Review plans for concrete curing and site drying to enable timely achievement of suitable slab moisture conditions.
6. Review concrete substrate tolerance requirements for acceptable terrazzo installation.
7. Review divider strip and control joint locations.

1.5 SUBMITTALS

A. Product Data:
   1. Samples for initial color selection.
   2. Submit product data for each material indicated. System will be evaluated on the basis of standards. For tests not listed in published data, manufacturer shall supply missing data according to standard referenced.
      a. Physical properties.
      b. Performance properties.
      c. Specified tests.
      d. Material Safety Data Sheet.
      e. Manufacturer's standard warranty.

B. Shop Drawings: Include terrazzo installation requirements. Include plans, elevations, sections, component details and attachments to other work. Show layout of the following:
   1. Indicate layout of abrasive strips at stair nosings.
   2. Indicate layout of stair treads and landings.
   3. Large scale details of precast terrazzo jointing and edge conditions, including anchorage details.
   4. Indicate layout of terrazzo patterns. Coordinate with Architect.
   5. Indicate layout of divider strips. Coordinate with Architect.
   6. Terrazzo patterns.
   7. Indicate layout of control and expansion joint strips, details and types. Coordinate with Architect.

C. Samples: Sample submittals shall match architect’s samples for each type, material, color and pattern of terrazzo and accessory required showing the full range of color, texture and pattern variations expected. Label each terrazzo sample to identify matrix color and aggregate types, sizes and proportions. Prepare samples of same thickness and from same material to be used for the work in size indicated below. Compliance with other requirements is the responsibility of the Contractor.
   1. Epoxy Terrazzo: Minimum 6-inch- (150mm-) square Samples.
   2. Precast Epoxy Terrazzo Tread: 12-inch- (300mm-) long Samples.
   3. Accessories: 6-inch- (150mm-) long Samples of each exposed strip item required.

D. Material Certificates: For each type of terrazzo flooring system product, provide supplier or manufacturer's written certificate stating that materials comply with or exceed NTMA specified properties and performance requirements of this Section.

E. Material Test Reports: For moisture and/or relative humidity of substrate, by a qualified testing agency.

F. Sample Warranties: For manufacturer's special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: NTMA maintenance recommendations and manufacturer’s instructions to include in maintenance manuals.

B. Repair Procedures: Provide written procedures for the following:
   1. Epoxy Terrazzo Flooring: Removal and replacing damaged portions of flooring.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Engage a terrazzo manufacturer with minimum 5 years documented manufacturing experience producing epoxy binder, and flexible crack isolation membranes; including the following:
   1. Proof of NTMA membership.
   2. Furnish documentation for at least 5 epoxy terrazzo projects of the same scope and complexity; installed in the past 5 years using material being submitted for this project.
   3. For each epoxy terrazzo project submitted, provide the following information:
      a. Project name.
      b. Square footage of terrazzo installed.
      c. Address of facility with contact name and phone number.
      d. Contact name, address and phone number of prime contractor or construction manager.
      e. Field experience resumes of key project personnel including lead supervisor and field technicians to be used on this project.

B. Installer Qualifications: Submit proof of Contractor's membership in NTMA or IMI with a letter recognizing that they are a qualified installer in good standing and is acceptable to epoxy terrazzo manufacturer.
   1. Furnish documentation for at least 3 epoxy terrazzo projects of the same scope and complexity; installed in the past 5 years using material being submitted for this project.
   2. For each epoxy terrazzo project submitted, provide the following information:
      a. Project name.
      b. Square footage of terrazzo installed.
      c. Lineal footage of precast base and cast in place base.
      d. Address of facility with contact name and phone number.
      e. Contact name, address and phone number of prime contractor or construction manager.
      f. Field experience resumes of key project personnel including lead supervisor and field technicians to be used on this project.
   3. For each epoxy terrazzo project submitted, provide the following information:

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in manufacturer's undamaged, unopened containers with a label on each container clearly marked with the following information:
   1. Product name.
   2. Manufacturer's name.

B. Handle materials by methods which prevent damage.

C. Inspect direct jobsite deliveries to assure quantities are correct; materials comply with requirements; and materials are not damaged.

D. Immediately return materials found to be defective in manufacturing and materials damaged in transit, handling or storage.
   1. Replace defective materials at no cost to Owner.

E. Store materials per manufacturer's instructions and as follows:
   1. Store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures and humidity.
   2. Maintain storage temperatures between 60° F (15.6° C) and 90° F (32.2° C).
   3. Maintain seals and labels intact and legible.
   4. Do not use materials which have been stored for a longer period of time than the manufacturer's maximum recommended shelf life.

1.9 FIELD CONDITIONS

A. Temperature:
   1. Maintain the ambient room and substrate temperature at 55° F (12.8° C) or above during stripping and pouring.
      a. Maintain this temperature at least 48 hours after completion of pouring.
   2. After terrazzo has been poured, maintain substrate temperature at 40° F (4.4° C) or above until substantial completion.
   3. Each day of installation, before beginning work, verify that the dew point is at least 5° F (-15.0° C) less than the slab and air temperature.

B. Verify that adequate ventilation is provided.

C. Maintain a minimum uniform level of 50-60 foot candles (538.2 Lux - 645.8 Lux) in areas where terrazzo system is being installed.

D. Acceptable Substrate Conditions:
   1. Flatness Tolerance: Maximum variation from flatness of 1/8 inch in 10 feet (6 mm in 3 m).
   2. Concrete floor Finish: Steel trowel finish.
   3. Allow concrete to receive epoxy terrazzo to cure for at least 30 days before beginning installation process.
      a. Allow no curing agents to be used in areas to receive terrazzo.
   4. Test concrete substrate to determine acceptable moisture levels prior to terrazzo

installation.

5. Saw cutting of control joints must be done between 12 and 24 hours after placement of the structural concrete and at a frequency compatible to ACI recommendations.

E. Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during terrazzo installation.

F. Close spaces to traffic during terrazzo application and for not less than 24 hours after application unless the manufacturer recommends a longer period.

G. Provide protection from other trades prior to final acceptance by owner.

H. Dust Control: Control and collect dust produced by grinding operations.

1.10 WARRANTY

A. Special Warranty: Manufacturer and installer, jointly, agree to provide labor and material to repair (and if necessary to replace) components of epoxy terrazzo flooring system that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, loss of bond and damage due to normal wear and tear.
   2. Failures do not include the following:
      a. Damage due to bubbling or loss of adhesion due to moisture penetration through the substrate.
      b. Acts of God or other elements beyond scope of protection of this system.
      c. Reflective cracks from substrate.
   3. Warranty Period: One year from date of Substantial Completion.
   4. Limitations:
      a. In case of warranty claim, Owner will provide written notice to terrazzo manufacturer and installer within 30 days of problem's discovery.
      b. Owner will provide free access to area during normal working hours.
      c. Owner assumes responsibility for protection and maintenance of epoxy terrazzo flooring from date of Substantial Completion on.
      d. Remedies provided by epoxy terrazzo flooring manufacturer and installer are limited to direct repair of Epoxy Terrazzo Flooring System.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide Basis of Design product or comparable product indicated on drawings.:

B. Source Limitations: Obtain primary Epoxy Terrazzo Flooring System materials including membranes, primers, resins, and hardening agents from a single manufacturer.
   1. Obtain aggregates, solvents, divider strips, sealers and cleaners from source recommended by primary materials manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. NTMA Standards: Comply with NTMA's "Terrazzo Specifications and Design Guide" and with written recommendations for terrazzo type indicated unless more stringent requirements are specified.

2.3 EPOXY TERRAZZO FLOORING SYSTEM - (TRZ-)

A. Materials:
1. Epoxy Resin: Manufacturer’s standard recommended for use indicated and in color required for mix indicated.
a. Physical Properties without Aggregates:
1) Hardness: ASTM D2240 70-85 Shore D.
2) Minimum Tensile Strength: 4,800 psi (33 mPA) per ASTM D638 for a 2-inch (50 mm) specimen made using a “C” die per ASTM D412.
3) Minimum Compressive Strength: 12,000 psi (83 mPA) per ASTM D695, Specimen B cylinder.
4) Chemical Resistance: No deleterious effects by contaminants listed below after 7-day immersion at room temperature per ASTM D1308.
a) Distilled water.
b) Mineral water.
c) Isopropanol.
d) Ethanol.
e) 0.025 percent detergent solution.
f) 1 percent soap solution.
g) 10 percent sodium hydroxide.
h) 10 percent hydrochloric acid.
i) 5 percent acetic acid.
b. Physical Properties with Aggregates: For resin blended with Georgia White marble, ground, grouted, and cured per requirements in NTMA’s “Guide Specification for Epoxy Terrazzo,” comply with the following:
1) Flammability: Self-extinguishing, maximum extent of burning 0.25 inch (6 mm) per ASTM D635.
2) Linear Coefficient of Thermal Expansion: 25.0x10-6 in/in per ºF (11.4x10-7 cm/cm per ºC) for temperature range of -12° to 140° F (-24° to 60° C) per ASTM D696.
3) Bond Strength: When tested in accordance with Field Test Method for surface soundness and adhesion as described in ACI Committee No. 403 Bulletin Title No. 59-43 the Epoxy terrazzo shall comply with the following value: 100 percent concrete failure minimum, with 300 psi (2.1 mPA) minimum tensile strength.

B. Mix: Comply with NTMA’s “Terrazzo Specifications and Design Guide” and manufacturer’s written instructions for matrix and aggregate proportions and mixing.
1. Color and Pattern Schedule: Where the following designations are indicated, provide specified terrazzo matrices matching architect’s samples:
a. As indicated on drawings.

2.4 DIVIDER AND ACCESSORY STRIPS

A. 096623.A - Thin -Set Divider Strips: L-type and T-type.
   1. Material: plastic in color selected from manufacturers product range.
   2. Top Width: 1/16 inch (1.6 mm).

B. Heavy-Top Divider Strips: Angle type in depth required for topping thickness indicated.
   1. Bottom-Section Material: Matching top-section material.
   2. Top-Section Material: White zinc alloy, unless otherwise indicated.
   3. Top-Section Width: 1/8 inch (3 mm) unless otherwise indicated.

C. Control joint Strips: Separate, double L-type divider strips, positioned back to back with 3/8 inch (9.5 mm) separation filled with sealant.

D. Nosings for Stair Treads and Landings: Extruded aluminum, with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder.
   1. Fabricate nosings in sizes and configurations indicated and in uninterrupted lengths necessary for an accurate fit.
   2. Available Manufacturers and Products:
      a. Wooster Products Inc. Type 128 with Time Saver Anchor.
      b. Balco Inc.
   3. Nosings: Square-back units, 1-7/8 inches (48 mm) wide with 1-1/8 inches (29 mm) lip, for casting into terrazzo steps.
   4. Provide anchors welded to underside of nosing for embedding units in terrazzo, as indicated on drawings.

2.5 MISELLANEOUS PRODUCTS

A. Concrete Patch and Topping: 100 percent solids fill mortar system including blended aggregate.
   1. Basis of Design Product: MorriFill™ Epoxy Slope and Fill Mortar.
   2. Compressive Strength: ASTM C579, 8,000 psi (55 mPA) minimum.
   3. Hardness: ASTM D2240, 75-80 Shore D.

B. Moisture Remediation System: Two-component formulation designed to reduce moisture vapor transmission through concrete and provide bond with epoxy terrazzo flooring system.
   1. Basis of Design: Morricite MVP™ Moisture Suppression System by Master Terrazzo Technologies.
   2. Adhesion: ASTM D4541, 500 psi (3.5 mPA).
   3. Moisture Vapor Transmission: ASTM E96, 0.131 perm.

C. Primer: 100 percent solids, epoxy primer moisture insensitive. No solvent containing primers are allowed.
   1. Basis of Design Product: Morricite® Primer.
   2. Moisture Vapor Transmission: ASTM E96, 1 perm maximum.

D. Crack Isolation Membrane.
   1. Basis of Design Product: MasterFlex™ Flexible Epoxy Membrane.
   2. Flexible Epoxy Membrane: Flexible epoxy membrane with 100 percent solids with the

following properties:
a. Tensile Strength: ASTM D2370 at 68° F (20° C) 1,500 psi (10 mPA).
b. Elongation: ASTM D2370 at 68° F (20° C) 130 percent.
c. Adhesion: ASTM D4541, 350 psi (2.4 mPA).

E. Membrane Reinforcing: Fiberglass mesh reinforcement fabric compatible with crack isolation membrane.
1. Basis of Design Product: MasterFlex™ Fabric.

F. Divider-Strip Adhesive: Epoxy-resin adhesive recommended by adhesive manufacturer for this use and acceptable to terrazzo manufacturer.
1. Use adhesive that has a VOC content of 50g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

G. Anchoring Devices:
1. Strips: Provide mechanical anchoring devices for strip materials as required for secure attachment to substrate.

H. Finishing Grout: Epoxy grout with 100 percent Solids.
1. Basis of Design Product: Morricite® Terrazzo Grout.

I. Control Joint Filler: Flexible, grindable, epoxy joint filler, 100 percent solids, with the following properties:
1. Basis of Design Product: MTT ColorFlex™.
2. Tensile Strength: ASTM D2370 at 68° F (20° C) 1,600 psi (11 mPA).
3. Elongation: ASTM D2370 at 68° F (20° C) 100 percent.
4. Tensile Modulus: ASTM D2370 at 68° F (20° C) 27,800 psi (192 mPA).
5. Color: As selected by the Architect.

J. Joint Sealant: Comply with requirements of Section 07 90 00 "Joint Sealants."

K. Expansion Joints: Comply with requirements of Section 07 90 00 "Joint Sealants" and Section 07 95 00 "Expansion Control".

L. Abrasive Strips: Metal channels matching strips to receive epoxy and abrasive aggregate.
1. Barrier free profile, extruded aluminum base and anchor for casting into concrete fill, aluminum oxide blend abrasive filled, ribbed style with anti-slip surface, color as selected; 3 inches wide by 1/8 inch less the tread width long.

M. Terrazzo Cleaner: As recommended by cleaner manufacturer for use on terrazzo type specified and as follows:
1. Biodegradable.
2. Chemically neutral.
3. pH factor between 7 and 10.
4. Free from phosphate, crystallizing salts, and water soluble alkaline salts.

N. Terrazzo Sealers: Slip- and stain-resistant sealer that is chemically neutral with a pH factor between 7 and 10, a standard coefficient of friction of 0.6 or higher, does not affect physical properties of terrazzo and complies with NTMA's "Terrazzo Specifications and Design Guide.".
   1. General: Provide sealers produced by or approved by terrazzo flooring system manufacturer.
   2. Water Based Sealer: Provide a medium gloss water based sealer and finish system.
      a. Basis of Design Product: MTT SealOn Waterborne Sealer.

2.6 SOURCE QUALITY CONTROL

A. Testing: Test and inspect epoxy terrazzo flooring according to the following requirements:
   1. Cure specimens for 7 days at 75° F (28.9° C) plus or minus 2° F (1.1° C) and 50 percent plus or minus 2 percent RH.
   2. Conduct tests according to the test methods indicate for each product and characteristic indicated above in Part 2 of this Section.

B. Epoxy terrazzo flooring will be considered defective if it does not pass tests and inspections.
   1. Acceptable results for each product and characteristic indicated above in Part 2 of this Section.

C. Prepare test and inspection reports.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and areas, with Terrazzo Contractor present, for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Evaluate slab condition, including slab moisture content and extent of repairs required to comply with substrate requirements of NTMA's "Terrazzo Specifications and Design Guide" and the requirements of this Section.
   2. Verify that concrete substrate was poured no fewer than 30 days prior to date of examinations.
   3. Verify existing work has no defects affect proper execution of terrazzo work.
   4. Verify that concrete substrate meets flatness tolerances.
   5. Verify that concrete substrates are visibly dry and free of moisture.

B. Prepare written preconstruction examination report, endorsed by Installer, listing conditions detrimental to performance.

C. Proceed with installation only after unsatisfactory conditions, including flatness tolerances, have been corrected.

D. Verify measurements and dimensions; coordinate the installation of insert and work of other trades.

3.2 PREINSTALLATION TESTING

A. Concrete Moisture Testing, General.
   1. Conduct relative humidity test at each test site.
   2. Conduct one pH test at each test site.

B. Calcium Chloride Testing:
   1. Perform tests in accordance with ASTM F1869.

C. Relative Humidity Testing:
   1. Perform tests in accordance with ASTM Fse.
   2. All ASTM F2170 procedures must be followed. Note that service conditions must be maintained for the prescribed period of time according to ASTM F2170, leading up to and during the testing period.

D. Proceed with terrazzo installation only after substrates have a maximum relative humidity measurement reading less than 75 percent per ASTM F2170.
   1. If concrete substrate moisture meets or exceeds 75% according to ASTM F2170, consult terrazzo manufacturer for additional moisture remediation methods.

3.3 PREPARATION

A. Clean substrates of substances, including oil, grease and curing compounds, that might impair terrazzo bond. Provide clean, dry and neutral substrate for terrazzo application.

B. Provide clean, dry, and neutral substrate for terrazzo application.
   1. Determine dryness characteristics by performing moisture tests recommended by terrazzo manufacturer.

C. Concrete Slabs:
   1. Provide sound concrete surface free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil and other contaminants incompatible with epoxy terrazzo.
      a. Prepare concrete mechanically by shot blasting or by grinding.
         1) Surface preparation results should achieve a CSP3-CSP4 profile according to International Concrete Repair Institute Guideline No. 03732.
      b. Remove contaminating and bond breaking substances including but not limited to the following:
         1) Dust.
         2) Laitance.
         3) Curing compounds.
         4) Coatings.
         5) Sealers.
         6) Oil.
         7) Grease.
         8) Mastics.
         9) Adhesives.
      c. Chemically remove oil and grease not removed by vacuum blasting.
      d. Mechanically remove spalled and deteriorated concrete with scabbling or chipping

hammers.
e. Do not acid etch concrete.
f. Repair or level damaged concrete with concrete patch and topping.
g. Do not use latex fills and self leveling underlayments.
h. Cracks and non-expansion joints greater than 1/16 inch (1.6 mm) wide after surface preparation shall be prepared until sound.
1) Repair cracks and non-expansion joints according to NTMA Technical Bulletin #111.

D. Protect other work from dust generated by shot blasting and by grindingoperations. Control dust to prevent air pollution and comply with environmental protection regulations.
1. Erect and maintain temporary enclosures and other suitable methods to limit dust migration and to ensure adequate ambient temperatures and ventilation conditions during installation.

E. Protect other work from dust generated by grinding operations. Control dust to prevent air pollution and comply with environmental protection regulations.
1. Erect and maintain temporary enclosures and other suitable methods to limit dust migration and to ensure adequate ambient temperatures and ventilation conditions during installation.

3.4 INSTALLATION, EPOXY TERRAZZO

A. General:
1. NTMA Standards: Comply with NTMA's "Terrazzo Specifications and Design Guide" and with written recommendations for terrazzo type and accessory indicated unless more stringent requirements are specified within this section.
2. Comply with written directions of product manufacturer.
3. Ensure that matrix components and fluids from grinding operations do not stain terrazzo by reacting with divider and control joint strips.
4. Delay fine grinding until heavy trade work is complete and construction traffic through area is restricted.

B. Full Membrane Application.
1. Flexible Reinforcing Membrane:
a. Prepare and prefill substrate cracks with 100% solids epoxy and allow to cure.
b. Apply 25 mils of crack isolation membrane over prepared substrate to produce full substrate coverage in areas to receive terrazzo.
c. Apply second coat of crack isolation membrane, 15 mils thick and install reinforcing fabric.
d. Prepare membrane according to manufacturer's written instructions before applying primer.
2. Primer: Install primer if required by manufacturer over crack isolation membrane.

C. Crack Detailing Application.
1. Crack Treatment Type 1: After surface preparation, fill cracks less than 1/16 inch (1.6 mm) wide with 100% solids epoxy or primer.
2. Crack Treatment Type 2: Fill cracks and joints which are greater than 1/16 inch (1.6 mm)

width with 100% solids epoxy or primer.
   a. Apply minimum 30 mil detail coat of crack isolation membrane. Extend coverage at least 12 inches (300 mm) on each side of crack for a total of 12” wide (+/-).
   b. If crack is greater than 1/8”, after crack isolation membrane has leveled, lay minimum 9 inches (230 mm) wide precut strips of membrane reinforcing fabric into uncured crack isolation membrane. Saturate reinforcing fabric with additional crack isolation membrane.
3. Primer: Apply epoxy primer evenly over entire prepared substrate, including cracks and non-expansion joints, at a rate of 200-250 square feet per gallon (5 - 6 sq. m per liter).
   a. Thoroughly wet surface with primer.
   b. Do not allow primer to pond.

D. Divider and Accessory Strips: Install in locations indicated in adhesive setting bed without voids below strips.
1. Anchoring Strips: Adhere the strips to the floor with primer or hot glue.

E. Placing Terrazzo:
1. Mix terrazzo binder with chips and fillers in ratios as approved by manufacturer.
2. Trowel-apply terrazzo mixture over epoxy primer to provide smooth seamless surface at a minimum of 3/8 inch (9.5 mm) thick.
   a. Allow terrazzo mixture to cure per manufacturer's recommendations prior to grinding operations.

F. Nosings for Cast Stair Treads and Landings: Install nosings in sizes and configurations indicated and in uninterrupted lengths necessary for an accurate fit with clear lacquer applied to concealed bottoms, sides, and edges of extruded units set into terrazzo.

G. Rough Grinding: Grind with 24 grit or finer stones or with comparable diamond plates.

H. Intermediate Grinding: Follow initial grind with 80 grit or finer stones.

I. Grouting: Prior to final grinding, apply epoxy grout as follows:
1. Cleanse floor with clean water and rinse thoroughly.
2. Remove excess rinse water by wet vacuum and machine until completely dry.
3. Apply epoxy grout to fill voids.

J. Fine Grinding: Grind with 120 grit or finer stones until all grout is removed from surface.
1. Repeat rough grinding, grout coat, and fine grinding if large voids exist after initial fine grinding.
2. Produce surface with a minimum of 70 percent aggregate exposure.

K. Remove terrazzo in areas where terrazzo fails to bond properly to substrate and install new terrazzo.
1. Cut out terrazzo areas in panels defined by strips and replace to match adjacent terrazzo.

L. Construction Tolerances: Limit variation in terrazzo surface from level 1/4 inch in 10 feet (6 mm in 3 m).

3.5 ADJUSTING

A. Cut out and replace terrazzo areas that evidence lack of bond with substrate. Cut out terrazzo areas in panels defined by strips and replace to match adjacent terrazzo, or repair panels according to NTMA's written recommendations, as approved by Architect.

3.6 CLEANING

A. Cleaning:
   1. Wash surfaces with cleaner according to NTMA's Maintenance Guide and manufacturer's written instructions.
   2. Remove grinding dust from installation and wash surfaces according to manufacturers recommended cleaning procedures.
   3. Allow surfaces to thoroughly dry before sealing.

3.7 PROTECTION

A. Protect surrounding substrates and surfaces, as well as in-place equipment from damage during surface preparation and system application.

B. Maintain area where terrazzo work is being done be free of other trades during surface preparation, crack detailing, divider strip installation, terrazzo pouring, and for a period of 36 hours upon completion.

C. Sealing:
   1. Seal surfaces according to NTMA's written recommendations.
   2. Apply terrazzo sealer according to sealer manufacturer's written instructions.

D. Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure terrazzo is without damage or deterioration at time of Final Acceptance.

END OF SECTION 096623

SECTION 096813 - TILE CARPETING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Carpet tile.

B. Related Requirements:
   1. Section 096513 "Resilient Base and Accessories" Section 096519 "Resilient Tile Flooring" for resilient wall base and accessories installed with carpet tile.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
   2. Include manufacturer's written installation recommendations for each type of substrate.

B. Samples for Verification: Actual sample of finished products for each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
   1. Carpet Tile: Full-size Sample.
   2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch- (300-mm-) long Samples.

C. Product Schedule: For carpet tile. Use same designations indicated on Drawings.

D. Pre-Installation Meeting: On-Site.

1.3 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.

B. Qualification Statements: For Installer.

C. Sample Warranties: For carpet tile.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For carpet tiles. Include the following:
   1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
   2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials, from the same production run, to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but no fewer than 10 full-size units.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with CRI 104.

1.7 FIELD CONDITIONS

A. Comply with CRI 104 for temperature, humidity, and ventilation limitations.

B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.

C. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

1.8 WARRANTY

A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
   1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
   2. Failures include, but are not limited to, the following:
      a. More than 10 percent loss of face fiber, edge raveling, snags, and runs.
      b. Loss of tuft-bind strength.
      c. Excess static discharge.
      d. Delamination.
      e. Dimensional instability.
   3. Warranty Period: Lifetime commercial limited to match basis of design product.

PART 2 PRODUCTS

2.1 CARPET TILE (CPT-)

A. Manufacturers: Subject to compliance with requirements, provide Basis of Design product or comparable product indicated on drawings.

2.2 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended in writing by carpet tile manufacturer.

B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive types to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and that are recommended in writing by carpet tile manufacturer for releasable installation.
   1. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance.

B. Examine carpet tile for type, color, pattern, and potential defects.

C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 033000 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.
   1. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. (20 sq. m), and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
      a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/100 sq. m) in 24 hours.
      b. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
      c. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Comply with CRI 104 and with carpet tile manufacturer's written installation instructions for preparing substrates.

B. Use trowelable leveling and patching compounds, in accordance with manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch (3 mm) wide or wider, and protrusions more than 1/32 inch (0.8 mm) unless more stringent requirements are required by manufacturer's written instructions.

C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.

D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

A. General: Comply with CRI 104, Section 10, "Carpet Tile," and with carpet tile manufacturer's written installation instructions.

B. Installation Method: As recommended in writing by carpet tile manufacturer.

C. Maintain dye-lot integrity. Do not mix dye lots in same area.

D. Maintain pile-direction patterns recommended in writing by carpet tile manufacturer.

E. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended in writing by carpet tile manufacturer.

F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.

H. Install pattern parallel to walls and borders.

3.4 CLEANING AND PROTECTION

A. Perform the following operations immediately after installing carpet tile:
   1. Remove excess adhesive and other surface blemishes using cleaner recommended in writing by carpet tile manufacturer.
   2. Remove yarns that protrude from carpet tile surface.
   3. Vacuum carpet tile using commercial machine with face-beater element.

B. Protect installed carpet tile to comply with CRI 104, Section 13.7.

C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

D. Add Ramboard to protect flooring until beneficial completion.

END OF SECTION 096813

SECTION 097505 - ULTRA COMPACT SURFACING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes.
   1. Ultracompact Surfacing.
   2. Setting materials and accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For countertop materials.

B. Samples for Verification: For the following products:
   1. Countertop material, 6 inches square.

C. Shop Drawings:
   1. Plans, sections, details, edge and backsplash profiles, and attachments to other work.
   2. Locations and details of joints.
   3. Direction of veining, grain, or other directional pattern.
   4. Locations and sizes of cutouts and holes for items installed in countertop.

D. Samples: For each stone type, in sets not less than 12 inches (300 mm) square.
   1. Include two or more Samples in each set and show the full range of variations in appearance characteristics expected in the completed Work.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

1.4 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of wall system to be performed according to manufacturers' written instructions and warranty requirements.

B. Field Measurements: Take field measurements before fabrication to the greatest extent practical. Coordinate fabrication schedule with construction so that work can be performed as quickly as possible without delays due to fabrication and delivery.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For ultra-compact surface. Include product data for care products used or recommended by Installer, and names, addresses, and telephone numbers of local sources for products.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate countertops similar to that required for this Project, and whose products have a record of successful in-service performance.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store and handle stone and related materials to prevent deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping, and other causes.
   1. Lift stone with wide-belt slings; do not use wire rope or ropes that might cause staining. Move stone, if required, using dollies with cushioned wood supports.

1.8 FIELD CONDITIONS

A. Field Measurements: Verify dimensions of countertops by field measurements after base cabinets are installed but before countertop fabrication is complete.

1.9 COORDINATION

A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 PRODUCTS

2.1 SOURCE LIMITATIONS

A. Panels: Obtain panel of each type and color or finish from a single source or producer.
   1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.

2.2 ULTRA COMPACT SURFACING - (UCS-X)

A. Manufacturers: Subject to compliance with requirements, provide Basis of Design product or comparable product indicated on drawings.

2.3 ADHESIVE MECHANICAL ANCHORING SYSTEM

A. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.4, ANSI 118.11 and ANSI A118.15 and is recommended by manufacturer for application indicated. Include reinforcement and accessories recommended by manufacturer.
   1. Manufacturers: Subject to compliance with requirements, provide product per the manufacturer's standard.

2.4 WATERPROOF MEMBRANES

A. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.10 and ANSI A118.12 and is recommended by manufacturer for application indicated. Include reinforcement and accessories recommended by manufacturer.

B. Waterproof Membrane, Fluid Applied: Liquid-latex rubber or elastomeric polymer with continuous fabric reinforcement.
   1. Manufacturers: Subject to compliance with requirements, provide product per the manufacturer's standard.

2.5 CRACK ISOLATION MEMBRANES

A. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.12 for high performance and is recommended by manufacturer for application indicated. Include reinforcement and accessories recommended by manufacturer.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean surfaces to receive panels; remove loose and foreign matter than could interfere with adhesion.

3.2 INSTALLATION SCHEDULE

A. Countertop Installation.
   1. Set in thin set mortar bed in accordance with ANSI A 108.5.
   2. Set plumb and level. Align adjacent pieces in same plane.
   3. Install with hairline joints.
   4. Fill joints between countertops and adjacent construction with joint sealer; finish smooth and flush.

B. Exterior Facade Panel Installation.
   1. Install with the DKT1 Fixing Standard or similar per manufacturer's recommendation.
   2. Apply adhesive to supporting wall and ultra compact surface.
   3. Set plumb and level. Align adjacent pieces in same plane.
   4. Install with hairline joints.

5. Set plumb and level. Align adjacent pieces in same plane.
6. Fill joints between countertops and adjacent construction with joint sealer; finish smooth and flush.

3.3 INSTALLATION TOLERANCES

A. Maximum variation from level and plumb: 1/8 inch in 10 feet, noncumulative.

B. Maximum variation in plane between adjacent pieces at joint: Plus or minus 1/16 inch.

3.4 CLEANING

A. Clean surfaces in accordance with manufacturer's instructions.

3.5 PROTECTION

A. Protect installed surfaces with nonstaining sheet coverings.

END OF SECTION 097505

SECTION 098433 - SOUND-ABSORBING WALL UNITS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sound-absorbing wall panels.

1.2 DEFINITIONS

A. NRC: Noise Reduction Coefficient.

B. SAA: Sound Absorption Average.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include fabric facing, panel edge, core material, and mounting indicated.

B. Samples for Verification: For the following products:
   1. Panel Sample: Full size product sample from the dye lot to be used for the Work, and with specified treatments applied.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Elevations and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Electrical outlets, switches, and thermostats.
   2. Items penetrating or covered by units including the following:
      a. Air outlets and inlets.
      b. Speakers.
      c. Alarms.
      d. Fire Protection Devices.
      e. Electronic Device Mounting Brackets.

B. Product Certificates: For each type of unit.

C. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of unit to include in maintenance manuals. Include fabric manufacturers' written cleaning and stain-removal instructions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials from same production run that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fabric: For each fabric, color, and pattern installed, provide length equal to 10 percent of amount installed, but no fewer than 10 sq. yd. (9 sq. m), full width of bolt.
   2. Mounting Devices: Full-size units equal to 5 percent of amount installed, but no fewer than five devices, including unopened adhesives.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with fabric and unit manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.

B. Deliver materials and units in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not install units until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work at and above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Lighting: Do not install units until a permanent level of lighting is provided on surfaces to receive the units.

C. Air-Quality Limitations: Protect units from exposure to airborne odors, such as tobacco smoke, and install units under conditions free from odor contamination of ambient air.

D. Field Measurements: Verify unit locations and actual dimensions of openings and penetrations by field measurements before fabrication, and indicate them on Shop Drawings.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace units and components that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to the following:
      a. Acoustical performance.
      b. Fabric sagging, distorting, or releasing from panel edge.
      c. Warping of core.
   2. Warranty Period: 5 years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 SOUND-ABSORBING WALL UNITS

A. Sound-Absorbing Wall Panels (AWP-X).
   1. Manufacturers: Basis of Design: Subject to compliance with requirements, provide Basis of Design product or comparable product indicated on drawings:
   2. Mounting: Per manufacturer's standards.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine fabric, fabricated units, substrates, areas, and conditions for compliance with requirements, installation tolerances, and other conditions affecting unit performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install units in locations indicated. Unless otherwise indicated, install units with vertical surfaces and edges plumb, top edges level and in alignment with other units, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.

B. Comply with manufacturer's written instructions for installation of units using type of mounting devices indicated. Mount units securely to supporting substrate.

3.3 INSTALLATION TOLERANCES

A. Variation from Plumb and Level: Plus or minus 1/16 inch (1.6 mm) in 48 inches (1200 mm), noncumulative.

B. Variation of Joint Width: Not more than 1/16-inch (1.6-mm) variation from reveal line in 48 inches (1200 mm), noncumulative.

3.4 CLEANING

A. Clip loose threads; remove pills and extraneous materials.

B. Clean panels on completion of installation to remove dust and other foreign materials in accordance with manufacturer's written instructions.

END OF SECTION 098433

SECTION 098436 - SOUND-ABSORBING CEILING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes shop-fabricated, acoustical panel units tested for acoustical performance, including the following:

1. Sound-absorbing baffle panels.

1.3 DEFINITIONS

A. NRC: Noise Reduction Coefficient.

B. SAA: Sound Absorption Average.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include fabric facing, panel edge, core material, and mounting indicated.

B. Samples for Verification: For the following products:

1. Panel Sample: Full-width by approximately 36-inch long Sample, from dye lot to be used for the Work, and with specified treatments applied.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Items penetrating or covered by units including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Alarms.
    e. Sprinklers.
    f. Access panels.

B. Product Certificates: For each type of unit.

C. Sample Warranty: For manufacturer's special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of unit to include in maintenance manuals. Include fabric manufacturer's written cleaning and stain-removal instructions.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
    1. Baffles: For each fabric, color, and pattern installed, furnish equal to 5% of amount installed.
    2. Mounting Devices: Full-size units equal to 5 percent of amount installed, but no fewer than five devices.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with fabric and unit manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.

B. Deliver materials and units in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not install units until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work at and above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Lighting: Do not install units until a permanent level of lighting is provided on surfaces to receive the units.

C. Air-Quality Limitations: Protect units from exposure to airborne odors, such as tobacco smoke, and install units under conditions free from odor contamination of ambient air.

D. Field Measurements: Verify unit locations and actual dimensions of openings and penetrations by field measurements before fabrication, and indicate them on Shop Drawings.

1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace units and components that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Acoustical performance.
b. Fabric sagging, distorting, or releasing from panel edge.
c. Warping of core.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOUND-ABSORBING CEILING UNITS (SAC-1)

A. Manufacturers: Subject to compliance with requirements provide basis of design product or comparable product indicated on drawings.
1. Mounting: Back mounted with manufacturer's standard, secured to substrate.

2.2 EXAMINATION

A. Examine fabric, fabricated units, substrates, areas, and conditions for compliance with requirements, installation tolerances, and other conditions affecting unit performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

2.3 INSTALLATION

A. Install units in locations indicated. Unless otherwise indicated, install units with edges in alignment with walls and other units, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.

B. Comply with manufacturer's written instructions for installation of units using type of mounting devices indicated. Mount units securely to supporting substrate.

C. Align pattern and grain as indicated on Drawings.

2.4 INSTALLATION TOLERANCES

A. Variation from Alignment with Surfaces: Plus or minus 1/16 inch in 48 inches, noncumulative.

B. Variation from Level or Slope: Plus or minus 1/16 inch.

C. Variation of Joint Width: Not more than 1/16 inch wide from reveal line in 48 inches, noncumulative.

2.5 CLEANING

A. Clip loose threads; remove pills and extraneous materials.

B. Clean panels on completion of installation to remove dust and other foreign materials according to manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fabric, fabricated units, substrates, areas, and conditions for compliance with requirements, installation tolerances, and other conditions affecting unit performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install units in locations indicated. Unless otherwise indicated, install units with vertical surfaces and edges plumb, top edges level and in alignment with other units, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.

B. Comply with manufacturer's written instructions for installation of units using type of mounting devices indicated. Mount units securely to supporting substrate.

3.3 INSTALLATION TOLERANCES

A. Variation from Plumb and Level: Plus or minus 1/16 inch in 48 inches, noncumulative.

B. Variation of Joint Width: Not more than 1/16-inch variation from reveal line in 48 inches, noncumulative.

3.4 CLEANING

A. Clip loose threads; remove pills and extraneous materials.

B. Clean panels on completion of installation to remove dust and other foreign materials in accordance with manufacturer's written instructions.

END OF SECTION

END OF SECTION

SECTION 099113 - EXTERIOR PAINTING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Work Results:

B. Principal Products:

C. Section includes surface preparation and the application of paint systems on the following exterior substrates:
   1. Concrete masonry units (CMUs).
   2. Steel and iron.
   3. Galvanized metal.

D. Related Requirements:
   1. Section 051200 "Structural Steel Framing" for shop priming of metal substrates.
   2. Section 055000 "Metal Fabrications" for shop priming metal fabrications.
   3. Section 055213 "Pipe and Tube Railings" for shop priming pipe and tube railings.

1.3 DEFINITIONS

A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D523.

B. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.

C. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D523.

D. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.

E. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.

F. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D523.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.
   1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
   2. Indicate VOC content.

B. Samples for Initial Selection: For each type of topcoat product.

C. Samples for Verification: For each type of paint system and each color and gloss of topcoat.
   1. Submit Samples on rigid backing, 8 inches (200 mm) square.
   2. Apply coats on Samples in steps to show each coat required for system.
   3. Label each coat of each Sample.
   4. Label each Sample for location and application area.

D. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Paint: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

1.6 QUALITY ASSURANCE

A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Architect will select one surface to represent surfaces and conditions for application of each paint system.
      a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
      b. Other Items: Architect will designate items or areas required.
   2. Final approval of color selections will be based on mockups.
      a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
   3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Final Acceptance.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
   1. Maintain containers in clean condition, free of foreign materials and residue.
   2. Remove rags and waste from storage areas daily.

1.8 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. HYPERLINK "http://www.specagent.com/Lookup?ulid=11634" Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Benjamin Moore & Co.
   2. PPG Paints.
   3. Sherwin-Williams Company (The).

2.2 PAINT, GENERAL

A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."

B. Material Compatibility:
   1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
   2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

C. Colors: As selected by Architect from manufacturer's full range.
   1. Twenty percent of surface area will be painted with deep tones.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

C. Proceed with coating application only after unsatisfactory conditions have been corrected.
   1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
   1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
   1. Remove incompatible primers and re-prime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.

F. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer.

G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
   1. Use applicators and techniques suited for paint and substrate indicated.
   2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.

3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
4. Paint entire exposed surface of window frames and sashes.
5. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
6. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. Tint undercoats same color as topcoat, but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
1. Paint the following work where exposed to view:
a. Equipment, including panelboards and switch gear.
b. Uninsulated metal piping.
c. Uninsulated plastic piping.
d. Pipe hangers and supports.
e. Metal conduit.
f. Plastic conduit.
g. Tanks that do not have factory-applied final finishes.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 EXTERIOR PAINTING SCHEDULE

A. CMU Substrates:
   1. Water-Based Light Industrial Coating System MPI EXT 4.2C:
      a. Prime Coat: Block filler, latex, interior/exterior, MPI #4.
      b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
      c. Topcoat: Light industrial coating, exterior, water based (MPI Gloss Level 3), MPI #161.

B. Steel and Iron Substrates:
   1. Water-Based Light Industrial Coating System.
      a. Prime Coat: Primer, rust inhibitive, water-based MPI #107.
      b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
      c. Topcoat: Light industrial coating, exterior, water based, semi-gloss (MPI Gloss Level 5), MPI #174.

C. Galvanized-Metal Substrates:
   1. Water-Based Light Industrial Coating System.
      a. Prime Coat: Primer, rust inhibitive, water-based MPI #107.
      b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
      c. Topcoat: Light industrial coating, exterior, water based, semi-gloss (MPI Gloss Level 5), MPI #174.
      d.

BASIS OF DESIGN	COLOR & FINISH	LOCATION
Sherwin Williams	Color: TBD Finish: TBD	Exterior Doors and Frames
Sherwin Williams	Color: TBD Finish: TBD	Exterior Steel Framing and columns
Sherwin Williams	Color: TBD Finish: TBD	Miscellaneous Steel

END OF SECTION 099113

SECTION 099123 - INTERIOR PAINTING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Work Results:

B. Principal Products:

C. Section Includes:
   1. Primers.
   2. Water-based finish coatings.

D. Related Requirements:
   1. 099300 “Staining and Transparent Finishing” for surface preparation and the application of wood stains and transparent finishes on interior wood substrates.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.
   1. Include preparation requirements and application instructions.
   2. Indicate VOC content.

B. Samples for Verification: For each type of paint system and each color and gloss of topcoat.
   1. Submit samples on rigid backing, 8 inch square.

C. Apply coats on Samples in steps to show each coat required for system.

D. Label each coat of each sample.

E. Label each Sample for location and application area.

F. Product List:
   1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

G. Shop Drawings:
   1. Include plan and elevations showing location of each paint color and sheen.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Paint Products: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
   1. Maintain containers in clean condition, free of foreign materials and residue.
   2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures of less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 PRODUCTS

2.1 MANUFACTURERS (PT-X; SEE DRAWINGS)

A. Basis of Design: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Sherwin - Williams Company (The).
   2. Benjamin Moore & Co.
   3. PPG Paints.

2.2 PAINT PRODUCTS, GENERAL

A. Material Compatibility:
   1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

B. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its “MPI Approved Products Lists.”.

C. VOC Content: For field applications that are inside the weatherproofing system, paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:
   1. Primers, Sealers, and Undercoaters: 0 g/L.

D. VOC Content: For field applications inside the building, wall paints shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:
   1. Interior Flat Latex Wall Paint: 0 g/L.
   2. Interior Nonflat Latex Wall Paint: 0 g/L.

2.3 SOURCE QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:
   1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.

B. Testing agency will perform tests for compliance with product requirements.

C. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

2.4 PRIMERS

A. Interior, Institutional Zero VOC Primer Sealer: Water-based primer sealer with low-odor characteristics and a VOC of less than 0 grams per liter for use on new interior plaster, concrete, and gypsum wallboard surfaces that are subsequently to be painted with latex finish coats.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Sherwin Williams Company (The).
      b. Benjamin Moore & Co.
      c. PPG Paints.
   2. Gloss and Sheen Level: Manufacturer's standard flat finish.

2.5 WATER-BASED FINISH COATS

A. Interior, Latex, Institutional Zero VOC, Flat: White or colored latex paint with low-odor characteristics and a VOC of less than 0 grams per liter, for use in areas, such as hospitals and other occupied buildings, where the odor and VOC levels of conventional latex products would preclude their use.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Sherwin Williams Company (The).
      b. Benjamin Moore & Co.
      c. PPG Paints.
   2. Gloss and Sheen Level: Manufacturer's standard flat finish.

B. Interior, Latex, Institutional Low Odor/VOC, Eggshell: White or colored latex paint with low-odor characteristics and a VOC of less than 10 grams per liter, for use in areas, such as hospitals and other occupied buildings, where the odor and VOC levels of conventional latex products would preclude their use.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Sherwin Williams Company (The).
      b. Benjamin Moore & Co.
      c. PPG Paints.
   2. Gloss and Sheen Level: Manufacturer's standard eggshell finish.

C. Interior, Latex, Institutional Low Odor/VOC, Semigloss: White or colored latex paint with low-odor characteristics and a VOC of less than 10 grams per liter, for use in areas, such as hospitals and other occupied buildings, where the odor and VOC levels of conventional latex products would preclude their use.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Sherwin Williams Company (The).
      b. Benjamin Moore & Co.
      c. PPG Paints.
   2. Gloss Level: Manufacturer's standard semigloss finish.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
   1. Fiber-Cement Board: 12 percent.
   2. Gypsum Board: 12 percent.

C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

E. Proceed with coating application only after unsatisfactory conditions have been corrected.
   1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
   1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
   1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions.
   1. Use applicators and techniques suited for paint and substrate indicated.
   2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
   3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
   4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
   5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting Fire-Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
   1. Paint the following work where exposed in occupied spaces:
      a. Equipment, including panelboards.
      b. Uninsulated metal piping.

c. Uninsulated plastic piping.
d. Pipe hangers and supports.
e. Metal conduit.
f. Plastic conduit.
g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.

2. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
1. Do not clean equipment with free-draining water and prevent solvents, thinners, cleaners, and other contaminants from entering waterways, sanitary and storm drain systems, and ground.
2. Dispose of contaminants in accordance with requirements of authorities having jurisdiction.
3. Allow empty paint cans to dry before disposal.
4. Collect waste paint by type and deliver to recycling or collection facility.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 INTERIOR PAINTING SCHEDULE

A. Gypsum Board Substrates:
1. Institutional Low-Odor/VOC Latex System MPI INT 5.1S:
a. Prime Coat: Interior, institutional Zero VOC primer sealer.
b. Intermediate Coat: Latex, interior, institutional Zero VOC, matching topcoat.
c. Topcoat: Interior, latex, institutional Zero VOC, flat eggshell.

B. Acoustic Panels and Tiles:
1. Institutional Low-Odor/VOC Latex System:
a. Prime Coat: Matching topcoat.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, latex, institutional low odor/VOC, flat.

C. CMU Substrates:
1. High-Performance Architectural Epoxy System MPI INT 4.2G:
2.

a. First Coat: Block filler, compatible with topcoat in written instructions by manufacturer, interior/exterior, MPI #4.
b. Intermediate Coat: Light-Industrial coating, interior, water-based epoxy, matching topcoat.
c. Topcoat: Light-Industrial coating, interior, water-based epoxy.

D. Concrete Substrates, Nontraffic Surfaces:
1. Institutional Zero VOC Epoxy System:
a. Prime Coat: Primer sealer, exterior, institutional zero VOC.
b. Intermediate Coat: Latex, exterior institutional zero VOC, matching topcoat.
c. Topcoat: Latex, interior institutional zero VOC, Flat.

3.6 INTERIOR PAINT COLOR SCHEDULE

A. As indicated on drawings.

END OF SECTION 099123

SECTION 099300 - STAINING AND TRANSPARENT FINISHING

PART 1 GENERAL

1.1 SUMMARY

A. Work Results:

B. Principal Products:

C. Section Includes:
1. Primers.
2. Transparent finishes.

D. Related Requirements:
1. Section 099123 "Interior Painting" for stains and transparent finishes on concrete floors.

1.2 ACTION SUBMITTALS

A. Product Data:
1. For each type of product.
2. Include preparation requirements and application instructions.
3. Indicate VOC content.

B. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.

C. Samples for Verification: Sample for each type of finish system and in each color and gloss of finish required on representative samples of actual wood substrates.
1. Size: 8 inches (200 mm) square.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

D. Product List: Cross-reference to finish system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.3 MOCKUPS

A. Apply mockups of each finish system indicated and each color selected to verify preliminary selections made under Sample submittals and to set quality standards for materials and execution.
1. Architect will select one surface to represent surfaces and conditions for application of each type of finish system and substrate.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
   1. Maintain containers in clean condition, free of foreign materials and residue.
   2. Remove rags and waste from storage areas daily.

1.5 FIELD CONDITIONS

A. Apply finishes only when temperature of surfaces to be finished and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply finishes when relative humidity exceeds 85 percent, at temperatures of less than 5 deg F (3 deg C) above the dew point, or to damp or wet surfaces.

C. Do not apply exterior finishes in snow, rain, fog, or mist.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Benjamin Moore & Co.
   2. PPG Paints.
   3. Sherwin-Williams Company (The).

2.2 SOURCE LIMITATIONS

A. Source Limitations: Obtain each coating product from single source from single manufacturer.

2.3 MATERIALS, GENERAL

A. Material Compatibility:
   1. Provide materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

2.4 PRIMERS

A. Alkyd Sanding Sealer, Interior, Solvent Based, Clear: Solvent-based, quick-drying, clear, sandable alkyd sealer used on new interior wood surfaces that are to be top-coated with an alkyd varnish.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. PPG Paints.
      b. Sherwin-Williams Company (The).

2.5 TRANSPARENT FINISHES

A. Varnish, Interior, Water Based, Clear, Satin: Water-based clear satin coating for interior wood trim, frames, doors, paneling and cabinetry.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Benjamin Moore & Co.
      b. PPG Paints.
      c. Sherwin-Williams Company (The).
   2. Gloss and Sheen Level: Gloss of 20 to 35 units at 60 degrees and minimum sheen of 35 units at 85 degrees when tested in accordance with ASTM D523.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Exterior Wood Substrates: 15 percent, when measured with an electronic moisture meter.

C. Maximum Moisture Content of Interior Wood Substrates: 9 percent, when measured with an electronic moisture meter.

D. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

E. Proceed with finish application only after unsatisfactory conditions have been corrected.
   1. Beginning finish application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

A. Remove hardware, covers, plates, and similar items already in place that are removable. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and finishing.
   1. After completing finishing operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

B. Clean and prepare surfaces to be finished according to manufacturer's written instructions for each substrate condition and as specified.
   1. Remove dust, dirt, oil, and grease by washing with a detergent solution; rinse thoroughly with clean water and allow to dry. Remove grade stamps and pencil marks by sanding lightly. Remove loose wood fibers by brushing.
   2. Remove mildew by scrubbing with a commercial wash formulated for mildew removal and as recommended by stain manufacturer.

C. Interior Wood Substrates:
   1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
   2. Apply wood filler paste to open-grain woods to produce smooth, glasslike finish.
   3. Sand surfaces exposed to view and dust off.
   4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dry.

3.3 APPLICATION

A. Apply finishes according to manufacturer's written instructions.
   1. Use applicators and techniques suited for finish and substrate indicated.
   2. Finish surfaces behind movable equipment and furniture same as similar exposed surfaces.
   3. Do not apply finishes over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

B. Apply finishes to produce surface films without cloudiness, holidays, lap marks, brush marks, runs, ropiness, or other surface imperfections.

3.4 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing finish application, clean spattered surfaces. Remove spattered materials by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from finish application. Correct damage by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or

defaced finished wood surfaces.

3.5 INTERIOR WOOD-FINISH-SYSTEM SCHEDULE

A. Wood Substrates, Casework:
   1. Water-Based Varnish over Stain System 064023.03:

END OF SECTION 099300

SECTION 099600 - HIGH-PERFORMANCE COATINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. High performance coatings.

B. Surface preparation.

1.2 RELATED REQUIREMENTS

A. Section 099113 - Exterior Painting.

1.3 REFERENCE STANDARDS

A. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association; Current Edition.

B. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual; Current Edition.

C. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. SSPC-SP 1 - Solvent Cleaning; 2015, with Editorial Revision (2016).

E. SSPC-SP 6 - Commercial Blast Cleaning; 2007.

1.4 SUBMITTALS

A. Product Data: Provide complete list of all products to be used, with the following information for each:
   1. Manufacturer's name, product name and/or catalog number, and general product category (e.g. "alkyd enamel").
   2. MPI product number (e.g. MPI #47) if applicable.
   3. Cross-reference to specified coating system(s) product is to be used in; include description of each system.

B. Samples: Submit two samples 8 by 8 inch in size illustrating colors for verification.

C. Manufacturer's Certificate: Certify that high-performance coatings comply with VOC limits specified.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

F. Maintenance Data: Include cleaning procedures and repair and patching techniques.

G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. Extra Coating Materials: 1 gallon of each type and color.
   2. Label each container with manufacturer's name, product number, color number, and room names and numbers where used.

1.5 QUALITY ASSURANCE

A. Applicator Qualifications: Company specializing in performing the work of this section with minimum five years experience.

1.6 MOCK-UPS

A. Provide mock-up , 4 feet long by 4 feet wide, illustrating coating, color, and surface sheen , for each specified coating.

B. Locate where directed.

C. Mock-up may remain as part of the work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

B. Container Label: Include manufacturer's name, type of coating, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

C. Coating Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.8 FIELD CONDITIONS

A. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.

B. Do not install materials when temperature is below 55 degrees F or above 90 degrees F.

C. Maintain this temperature range, 24 hours before, during, and 72 hours after installation of coating.

D. Restrict traffic from area where coating is being applied or is curing.

1.9 WARRANTY

A. Correct defective Work within a five year period after Date of Substantial Completion.

B. Warranty: Include coverage for bond to substrate and degradation of chemical resistance.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Provide high performance coating products from the same manufacturer to the greatest extent possible.
   1. In the event that a single manufacturer cannot provide specified products, minor exceptions will be permitted provided approval by Architect is obtained using the specified procedures for submittals.
   2. Substitution of MPI-approved products by a different manufacturer is preferred over substitution of unapproved products by the same manufacturer.
   3. Substitution of a different high performance coating system using MPI-approved products by the same manufacturer will be considered.

B. High-Performance Coatings:
   1. Basis of Design: Tnemec Company, Inc: www.tnemec.com/#sle.
   2. Dow: www.dow.com/#sle.
   3. PPG Paints: www.ppgpaints.com/#sle.

2.2 HIGH-PERFORMANCE COATINGS

A. Provide coating systems that meet the following minimum performance criteria, unless more stringent criteria are specified:
   1. Surface Burning Characteristics: Flame spread/Smoke developed index of 0/0, maximum, when tested in accordance with ASTM E84.
   2. NFPA 101, Class A rated.

2.3 TOP COAT MATERIALS

A. Coatings - General: Provide complete multi-coat systems formulated and recommended by manufacturer for the applications indicated, in the thicknesses indicated; number of coats specified does not include primer or filler coat.
   1. Volatile Organic Compound (VOC) Content: See Section 01 61 16.

B. High-Build Epoxy Coating:
   1. Number of Coats: Two.
   2. Top Coat(s): Epoxy, High-Build.
      a. Sheen: Low gloss.

b. Basis of Design Product:
1) Tnemec Company, Inc; Series 66 Epoxoline: www.tnemec.com/#sle.

3. Primer: As specified under "PRIMERS" below.

2.4 PRIMERS

A. Primers: Provide the following unless other primer is required or recommended by coating manufacturer.
1. Zinc Rich, Urethane.
a. Basis of Design Product:
1) Tnemec Company, Inc; Series 90G-1K97: www.tnemec.com/#sle.

2.5 ACCESSORY MATERIALS

A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of coated surfaces.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Do not begin application of coatings until substrates have been properly prepared.

C. Verify that substrate surfaces are ready to receive work as instructed by the coating manufacturer. Obtain and follow manufacturer's instructions for examination and testing of substrates.

D. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.

3.2 PREPARATION

A. Clean surfaces of loose foreign matter.

B. Remove substances that would bleed through finished coatings. If unremovable, seal surface with shellac.

C. Remove finish hardware, fixture covers, and accessories and store.

D. Aluminum: Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.

E. Ferrous Metal:
1. Solvent clean according to SSPC-SP 1.

2. Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.
3. Remove rust, loose mill scale, and other foreign substances using using methods recommended in writing by paint manufacturer and blast cleaning according to SSPC-SP 6 "Commercial Blast Cleaning", and protect from corrosion until coated.

3.3 PRIMING

A. Apply primer to all surfaces, unless specifically not required by coating manufacturer. Apply in accordance with coating manufacturer's instructions.

3.4 COATING APPLICATION

A. Apply coatings in accordance with manufacturer's written instructions, to thicknesses specified or recommended and recommendations in MPI - Architectural Painting and Specification Manual.

B. Apply in uniform thickness coats, without runs, drips, pinholes, brush marks, or variations in color, texture, or finish. Finish edges, crevices, corners, and other changes in dimension with full coating thickness.

3.5 CLEANING

A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

B. Clean surfaces immediately of overspray, splatter, and excess material.

C. After coating has cured, clean and replace finish hardware, fixtures, and fittings previously removed.

3.6 PROTECTION

A. Protect finished work from damage.

END OF SECTION 099600

SECTION 102113.17 - PHENOLIC-CORE TOILET COMPARTMENTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Phenolic-core toilet compartments.

B. Related Requirements:
   1. Section 061000 "Rough Carpentry" for blocking.
   2. Section 102800 "Toilet, Bath, and Laundry Accessories" for accessories mounted on toilet compartments.

1.2 COORDINATION

A. Coordinate requirements for blocking, reinforcing, and other supports concealed within wall to ensure that toilet compartments can be supported and installed as indicated.

1.3 ACTION SUBMITTALS

A. Product Data.
   1. Phenolic-core toilet compartments.
      a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for toilet compartments.

B. Shop Drawings:
   1. Include plans, elevations, sections, details, and attachment details.
   2. Show locations of centerlines of toilet fixtures.
   3. Show locations of floor drains.

C. Samples for Verification: Actual sample of finished products for each type of toilet compartment, hardware, and accessory.
   1. Size: Manufacturers' standard size.

D. Product Schedule: For toilet compartments, prepared by or under the supervision of supplier, detailing location and selected colors for toilet compartment material.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For toilet compartments.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Door Hinges: One hinge(s) with associated fasteners.
   2. Latch and Keeper: One latch(es) and keeper(s) with associated fasteners.
   3. Door Bumper: One door bumper(s) with associated fasteners.
   4. Door Pull: One door pull(s) with associated fasteners.
   5. Fasteners: 10 fasteners of each size and type.

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements, and coordinate before fabrication.

PART 2 PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain phenolic-core toilet compartments from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

B. Structural Performance: Where grab bars are mounted on toilet compartments, design panels to comply with the following requirements:
   1. Panels are able to withstand a concentrated load on grab bar of at least 250 lbf (1112 N) applied at any direction and at any point, without deformation of panel.

C. Regulatory Requirements: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" for toilet compartments designated as accessible.

2.3 PHENOLIC-CORE TOILET COMPARTMENTS (102113.17)

A. Basis of Design: Subject to compliance with requirements, provide product indicated below by Bradley Corp., or by one of the following comparable products:
   1. Bobrick.
   2. ASI- American Standards Institute.

B. Toilet-Enclosure Style: Floor anchored.
   1. At Amphitheater restroom: Floor anchored - Overhead Braced.

C. Urinal-Screen Style: Wall hung.

D. Door, Panel, and Pilaster Construction: Solid phenolic-core material with melamine facing on both sides fused to substrate during manufacture (not separately laminated), and with eased and polished edges. Provide minimum 3/4-inch- (19-mm-) thick doors and pilasters and minimum 1/2-inch- (13-mm-) thick panels.

E. Urinal-Screen Construction: Matching panel construction.

F. Pilaster Shoes: Formed from stainless steel sheet, not less than 0.031-inch (0.79-mm) nominal thickness and 3 inches (76 mm) high, finished to match hardware.

G. Urinal-Screen Post: Manufacturer's standard post design of monolithic phenolic-core urinal screen cutout at bottom to form a post; with shoe and sleeve (cap) matching that on the pilaster.

H. Phenolic Compartment Finish:
   1. Black-Color Phenolic: Manufacturer's standard color.
      a. Color: See Finish Legend.

2.4 HARDWARE AND ACCESSORIES

A. Door Hardware and Accessories: Manufacturer's operating hardware and accessories.
   1. Hinges: Manufacturer's stainless steel, surface-mounted, paired, self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees, allowing emergency access by lifting door.
   2. Latch and Keeper: Manufacturer's standard stainless steel, surface-mounted latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at toilet enclosures designated as accessible.
   3. Coat Hook: Manufacturer's standard stainless steel combination hook and rubber-tipped bumper, sized to prevent inswinging door from hitting compartment-mounted accessories.
   4. Door Bumper: Manufacturer's standard stainless steel, rubber-tipped bumper at outswinging doors.
   5. Door Pull: Manufacturer's standard stainless steel pull at outswinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at toilet enclosures designated as accessible.

2.5 MATERIALS

A. Stainless Steel Castings: ASTM A743/A743M.

2.6 FABRICATION

A. Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories where required for attachment of toilet

accessories.

B. Floor-Anchored Units: Manufacturer's standard corrosion-resistant anchoring assemblies at pilasters and walls, with leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.

C. Floor-Anchored, Over-head Braced Units: Manufacturer's standard corrosion-resistant anchoring assemblies at pilasters and walls, with leveling adjustment nuts at pilasters for structural connection to floor and ceiling. Provide shoes at pilasters to conceal anchorage.

D. Door Size and Swings: Unless otherwise indicated, provide 24-inch- (610-mm-) wide, inswinging doors for standard toilet enclosures and 36-inch- (914-mm-) wide, outswinging doors with a minimum 32-inch- (813-mm-) wide, clear opening for toilet enclosures designated as accessible.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for fastening, support, alignment, operating clearances, and other conditions affecting performance of the Work.
   1. Confirm location and adequacy of blocking and supports required for installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.
   1. Maximum Clearances:
      a. Pilasters and Panels or Screens: 1/2 inch (13 mm).
      b. Panels or Screens and Walls: 1 inch (25 mm).
   2. No gaps permitted between doors and pilasters.

B. Floor-Anchored Units: Set pilasters with anchors penetrating not less than 2 inches (51 mm) into structural floor unless otherwise indicated in manufacturer's written instructions. Level, plumb, and tighten pilasters. Hang doors and adjust so tops of doors are level with tops of pilasters when doors are in closed position.

C. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

3.3 ADJUSTING

A. Hardware Adjustment: Adjust and lubricate hardware in accordance with hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION 102113.17

SECTION 102600 - WALL AND DOOR PROTECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Corner guards.

1.2 RELATED REQUIREMENTS

A. Section 055000 - Metal Fabrications: Corner guards fabricated from rolled metal sections or bent plate.

B. Section 055000 - Metal Fabrications: Anchors for attachment of work of this section, concealed in wall.

C. Section 055213 - Pipe and Tube Railings: Metal railings not intended to protect walls.

D. Section 087100 - Door Hardware: Standard protection plates and trim.

E. Section 092116 - Gypsum Board Assemblies: Placement of supports in stud wall construction.

F. Section 097200 - Wall Coverings: Terminating wall covering at wall and door protection.

1.3 REFERENCE STANDARDS

A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.

B. ASTM D256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics; 2023, with Editorial Revision.

C. ASTM D543 - Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents; 2021.

D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.

E. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2022.

F. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015, with Editorial Revision (2021).

G. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.

1.4 SUBMITTALS

A. Product Data: Indicate physical dimensions, features, wall mounting brackets with mounted measurements, anchorage details, and rough-in measurements.

B. Shop Drawings: Include plans, elevation, sections, and attachment details. Show design and spacing of supports for protective corridor handrails, required to withstand structural loads.

C. Samples: Submit samples illustrating component design, configurations, joinery, color and finish.
   1. Submit two sections of corner guards, bumper rails, and protective corridor handrails, 24 inches long.

D. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver wall and door protection items in original, undamaged protective packaging. Label items to designate installation locations.

B. Protect work from moisture damage.

C. Protect work from UV light damage.

D. Do not deliver products to project site until areas for storage and installation are fully enclosed, and interior temperature and humidity are in compliance with manufacturer's recommendations for each type of item.

E. Store products in either horizontal or vertical position, in compliance with manufacturer's instructions.

1.6 WARRANTY

A. Manufacturer Warranty: Provide 5-year manufacturer warranty for metal crash rails. Complete forms in Owner's name and register with manufacturer.
   1. Failures include, but are not limited to, the following:
      a. Structural failures or internal connection failures.
      b. Deterioration of materials beyond that expected of normal use, as intended by manufacturer.

PART 2 PRODUCTS

2.1 CORNER GUARDS

A. Surface-Mounted, Metal Corner Guards: Fabricated as one piece from formed or extruded metal with formed edges; with 90- or custom-degree turn to match wall condition.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. TheCornerGuardStore.
      b. American Metal Products, Inc.
      c. Global Industrial.
   2. Material: Aluminum, Type 5052.
      a. Thickness: Minimum 0.0600 inch (1.5 mm).
      b. Finish: Powder-coated, custom color to match adjacent wall paint at each location as selected by Architect.
      c. Corner: Square.
      d. Color: As selected from manufacturer's standard colors.
      e. Length: One piece.
   3. Wing Size: Nominal 3/4 by 3/4 inches (19 by 19 mm).
   4. Corner Radius: 1/8 inch (3 mm).
   5. Mounting: Adhesive.
   6. Length: Corner guards to continue full height of exposed wall. Lengths may vary per ceiling heights.

2.2 FABRICATION

A. Fabricate components with tight joints, corners and seams.

B. Pre-drill holes for attachment.

C. Form end trim closure by capping and finishing smooth.

2.3 SOURCE QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Provide wall and door protection systems of each type from a single source and manufacturer.

2.4 FINISHES

A. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that rough openings, concealed blocking, and anchors are correctly sized and located.

B. Verify that field measurements are as indicated on drawings.

C. Verify that substrate surfaces for adhered items are clean and smooth.
   1. Test painted or wall covering surfaces for adhesion in inconspicuous area, as recommended by manufacturer. Follow adhesive manufacturer's recommendations for remedial measures at locations and/or application conditions where adhesion test's results are unsatisfactory.

D. Start of installation constitutes acceptance of project conditions.

3.2 INSTALLATION

A. Installation Quality: Install wall protection according to manufacturer's written instructions, level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.

B. Mounting Heights: Install wall and door protection in locations and at mounting heights indicated on Drawings.

C. Accessories: Provide splices, mounting hardware, anchors, trim, joint moldings, and other accessories required for a complete installation.
   1. Provide anchoring devices and suitable locations to withstand imposed loads.
   2. Where splices occur in horizontal runs of more than 20 feet (6.1 m), splice aluminum retainers and plastic covers at different locations along the run, but no closer than 12 inches (305 mm) apart.
   3. Adjust end and top caps as required to ensure tight seams.

3.3 TOLERANCES

A. Maximum Variation From Required Height: 1/8 inch.

B. Maximum Variation From Level or Plane For Visible Length: 1/8 inch.

3.4 CLEANING

A. Immediately after completion of installation, clean plastic covers and accessories using a standard ammonia-based household cleaning agent.

B. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION 102600

SECTION 102800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Public-use washroom accessories.
   2. Childcare accessories.
   3. Janitor Items.

B. Related Requirements:
   1. Section 088300 "Mirrors" for frameless mirrors.

1.2 COORDINATION

A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.

B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.3 ACTION SUBMITTALS

A. Product Data: For each product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.

B. Samples: For each exposed product and for each finish specified, full size.

C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
   1. Identify locations using room designations indicated.
   2. Identify accessories using designations indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For accessories to include in maintenance manuals.

1.6 WARRANTY

A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, visible silver spoilage defects.
   2. Warranty Period: 15 years from date of Substantial Completion.

B. Manufacturer's Special Warranty for Hand Dryers: Manufacturer agrees to repair or replace hand dryers that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Structural Performance: Design accessories and fasteners to comply with the following requirements:
   1. Grab Bars: Installed units are able to resist 250 lbf (1112 N) concentrated load applied in any direction and at any point.
   2. Shower Seats: Installed units are able to resist 500 lbf concentrated load applied in any direction and at any point.

2.2 PUBLIC-USE WASHROOM ACCESSORIES

A. Source Limitations: Obtain each type of public-use washroom accessory from single source from single manufacturer.

B. Public-Use Washroom Accessories: Provide basis-of-design product or equivalent product as indicated on drawings.

2.3 CUSTODIAL ACCESSORIES

A. Source Limitations: Obtain each type of public-use washroom accessory from single source from single manufacturer.

B. Custodial Accessories: Provide basis-of-design product or equivalent product as indicated on drawings.

2.4 MATERIALS

A. Steel Sheet: ASTM A1008/A1008M, Designation CS (cold rolled, commercial steel), 0.036-inch- (0.9-mm-) minimum nominal thickness.

B. Galvanized-Steel Sheet: ASTM A653/A653M, with G60 (Z180) hot-dip zinc coating.

C. Galvanized-Steel Mounting Devices: ASTM A153/A153M, hot-dip galvanized after fabrication.

D. Fasteners: Screws, bolts, and other devices of same material as accessory unit, unless otherwise recommended by manufacturer or specified in this Section, and tamper and theft resistant where exposed, and of stainless or galvanized steel where concealed.

E. Mirrors: ASTM C1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.5 FABRICATION

A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.

B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 EXECUTION

3.1 INSTALLATION OF TOILET, BATH, AND LAUNDRY ACCESSORIES

A. Install accessories in accordance with manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
   1. Remove temporary labels and protective coatings.

B. Shower Seats: Install to comply with specified structural-performance requirements.

3.2 ADJUSTING AND CLEANING

A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.

B. Clean and polish exposed surfaces in accordance with manufacturer's written instructions.

END OF SECTION 102800

SECTION 104400 - FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Fire extinguishers.

B. Accessories.

1.2 RELATED REQUIREMENTS

A. Section 061000 - Rough Carpentry: Wood blocking product and execution requirements.

B. Section 092116 - Gypsum Board Assemblies: Roughed-in wall openings.

1.3 REFERENCE STANDARDS

A. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2013a (Reapproved 2017).

B. FM (AG) - FM Approval Guide; current edition.

C. NFPA 10 - Standard for Portable Fire Extinguishers; 2022.

D. UL (DIR) - Online Certifications Directory; Current Edition.

1.4 SUBMITTALS

A. Product Data: Provide extinguisher operational features.

B. Shop Drawings: Indicate cabinet physical dimensions and rough-in measurements for recessed cabinets.

C. Manufacturer's Installation Instructions: Indicate special criteria and wall opening coordination requirements.

D. Maintenance Data: Include test, refill or recharge schedules and re-certification requirements.

1.5 FIELD CONDITIONS

A. Do not install extinguishers when ambient temperature may cause freezing of extinguisher ingredients.

1.6 WARRANTY

A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Failure of hydrostatic test according to NFPA 10.
      b. Faulty operation of valves or release valves.
   2. Warranty Period: Six years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Fire Extinguishers:
   1. Kidde, a unit of United Technologies Corp: www.kidde.com/#sle.
   2. Larsen's Manufacturing Co: www.larsensmfg.com/#sle.
   3. Nystrom, Inc: www.nystrom.com/#sle.
   4. Potter-Roemer: www.potterroemer.com/#sle.

2.2 FIRE EXTINGUISHERS

A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
   1. Provide extinguishers labeled by UL (DIR) or FM (AG) for purpose specified and as indicated.

B. Multipurpose Dry Chemical Type Fire Extinguishers: Carbon steel tank, with pressure gauge.
   1. Class: A:B:C type.
   2. Size: 5 pound.
   3. Finish: Baked polyester powder coat color as selected.
   4. Temperature range: Minus 40 degrees F to 120 degrees F.

C. Dry Chemical Type Fire Extinguishers: Stainless steel tank, with pressure gauge.
   1. Class: K type.
   2. Size: 1.6 gallons.
   3. Finish: Polished stainless steel.
   4. Temperature range: Minus 20 degrees F to 120 degrees F.

2.3 FIRE EXTINGUISHER CABINETS

A. Fire Rating: Listed and labeled in accordance with ASTM E814 requirements for fire resistance rating of walls where being installed.

B. Wall Mounting Hardware: Manufacturer's recommended.

2.4 ACCESSORIES

A. Extinguisher Brackets: Formed steel, chrome-plated.

B. Lettering: “FIRE EXTINGUISHER” decal, or vinyl self-adhering, pre-spaced black lettering in accordance with authorities having jurisdiction (AHJ).

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify rough openings for cabinet are correctly sized and located.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Wall hang extinguishers plumb and level, 40 inches from finished floor to operable part of fire extinguisher unless noted otherwise.

C. Secure rigidly in place.

END OF SECTION 104400

SECTION 104413 - FIRE PROTECTION CABINETS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Fire-protection cabinets for the following:
      a. Portable fire extinguisher.

B. Related Requirements:
   1. Section 104416 "Fire Extinguishers" for portable, hand-carried fire extinguishers accommodated by fire-protection cabinets.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing semi-recessed method and relationships of box and trim to surrounding construction.

B. Shop Drawings: For fire-protection cabinets.
   1. Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each type of exposed finish required.

D. Samples for Initial Selection: For each type of exposed finish required.

E. Product Schedule: For fire-protection cabinets. Indicate whether recessed, semi-recessed, or surface mounted. Coordinate final fire-protection cabinet schedule with fire-extinguisher schedule to ensure proper fit and function. Use same designations indicated on Drawings.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For fire-protection cabinets to include in maintenance manuals.

1.5 COORDINATION

A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers and hose valves indicated are accommodated.

B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain fire-protection cabinets, accessories, and fire extinguishers from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E 814 for fire-resistance rating of walls where they are installed.

2.3 FIRE-PROTECTION CABINET

A. Cabinet Type: Suitable for fire extinguisher.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Fire-End & Croker Corporation.
      b. Guardian Fire Equipment, Inc.
      c. JL Industries, Inc.; a division of the Activar Construction Products Group.
      d. Larsens Manufacturing Company.
      e. Modern Metal Products, Division of Technico Inc.
      f. Nystrom, Inc.
      g. Potter Roemer LLC.

B. Cabinet Construction: Rated.

C. Cabinet Material: Stainless-steel sheet.

D. Semi-recessed Cabinet: One-piece combination trim and perimeter door frame overlapping surrounding wall surface, with exposed trim face and wall return at outer edge (backbend).
   1. Rolled-Edge Trim: 2-1/2-inch backbend depth.

E. Cabinet Trim Material: Same material and finish as door.

F. Door Material: Stainless-steel sheet.

G. Door Style: Fully glazed panel with frame.

H. Door Glazing: Tempered float glass (clear).

I. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
   1. Provide manufacturer's standard hinge, permitting door to open 180 degrees.

J. Accessories:
   1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
   2. Lettered Door Handle: One-piece, cast-iron door handle with the word "FIRE" embossed into face.
   3. Door Lock: Cam lock that allows door to be opened during emergency by pulling sharply on door handle.
   4. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as directed by Architect.
      a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER."
         1) Location: Applied to cabinet door.
         2) Application Process: Pressure-sensitive vinyl letters.
         3) Lettering Color: White.
         4) Orientation: Vertical.

K. Materials:
   1. Stainless Steel: ASTM A 666, Type 304.
      a. Finish: No. 4 directional satin finish.
   2. Tempered Float Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 3-mm thick, Class 1 (clear).

2.4 FABRICATION

A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
   1. Weld joints and grind smooth.
   2. Miter corners and grind smooth.
   3. Provide factory-drilled mounting holes.
   4. Prepare doors and frames to receive locks.
   5. Install door locks at factory.

B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles.
   1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
   2. Fabricate door frames of one-piece construction with edges flanged.
   3. Miter and weld perimeter door frames and grind smooth.

C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.5 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.

C. Finish fire-protection cabinets after assembly.

D. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine walls and partitions for suitable framing depth and blocking where semi-recessed cabinets will be installed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare recesses for semi-recessed fire-protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

A. General: Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.
   1. Fire-Protection Cabinets: 54 inches above finished floor to top of fire extinguisher.

B. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.
   1. Unless otherwise indicated, provide recessed fire-protection cabinets. If wall thickness is inadequate for recessed cabinets, provide semi-recessed fire-protection cabinets.
   2. Provide inside latch and lock for break-glass panels.
   3. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.

C. Identification:
   1. Apply vinyl lettering at locations indicated.

3.4 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as fire-protection cabinets

are installed unless otherwise indicated in manufacturer's written installation instructions.

B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

D. Touch up marred finishes or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet and mounting bracket manufacturers.

E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 104413

SECTION 104416 - FIRE EXTINGUISHERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

B. Related Requirements:
   1. Section 104413 "Fire Protection Cabinets."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.

B. Product Schedule: For fire extinguishers. Coordinate final fire-extinguisher schedule with fire-protection cabinet schedule to ensure proper fit and function. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.6 COORDINATION

A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Failure of hydrostatic test according to NFPA 10.
      b. Faulty operation of valves or release levers.
   2. Warranty Period: Six years from date of Final Acceptance.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Amerex Corporation.
      b. Ansul Incorporated; Tyco International.
      c. Badger Fire Protection.
      d. Buckeye Fire Equipment Company.
      e. Fire End & Croker Corporation.
      f. Guardian Fire Equipment, Inc.
      g. JL Industries, Inc.; a division of the Activar Construction Products Group.
      h. Kidde Residential and Commercial Division.
      i. Larsens Manufacturing Company.
      j. MOON American.
      k. Nystrom, Inc.
      l. Potter Roemer LLC.
   2. Valves: Manufacturer's standard.
   3. Handles and Levers: Manufacturer's standard.
   4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging.

B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 4-A:60-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

2.3 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Amerex Corporation.
      b. Ansul Incorporated; Tyco International.
      c. Badger Fire Protection.
      d. Buckeye Fire Equipment Company.
      e. Fire End & Croker Corporation.
      f. Guardian Fire Equipment, Inc.
      g. JL Industries, Inc.; a division of the Activar Construction Products Group.
      h. Larsens Manufacturing Company.
      i. Nystrom, Inc.
      j. Potter Roemer LLC.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
   1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
      a. Orientation: Vertical.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.
   1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
   1. Mounting Brackets: Top of fire extinguisher to be at 54 inches above finished floor.

B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION 104416

SECTION 105626 - POWDER COATED STEEL COLLECTIONS STORAGE FURNITURE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Work Results:

B. Principal Products:

C. Free standing powder coated steel collections storage furniture as follows. (See sheets A-631 & A-632 for locations):
   1. LCS-17 Lockable flat files (2) with metal base. Coordinate with millwork top.
   2. LCS-19 Modular Paintings Screen Storage. Coordinate with CMU/drywall surround.
   3. TBM-04 Metal Media Cabinets.
   4. UCS 21 Lockable flat files (6). Coordinate with millwork surround including millwork base and countertop. Coordinate with drywall for recess in wall to fit flat files.
   5. UCS 23 Lockable Objects Art Storage Cabinets. Coordinate with millwork surround.
   6. UCS-25 LCS-19 Modular Paintings Screen Storage. Coordinate with millwork/drywall surround.

D. Coordinate with millwork surrounds.

E. Coordinate with GWB surrounds.

1.2 RELATED SECTIONS

A. Architectural Woodwork - Section 064023.

B. Gypsum Drywall - Section 092900.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: At least 5 years experience fabricating and installing comparable work.

1.4 REFERENCES

A. B. American National Standards Institute (ANSI) Standards:
   1. Applicable standards for fasteners used for assembly.

B. American Society for Testing and Materials (ASTM) Standards:
   1. Applicable standards for steel sheet materials used for fabrication.

C. American Institute of Steel Construction (AISC) Standards:
   1. Applicable standards for steel materials used for fabrication.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's product literature and installation instructions for each type of furniture and installation accessories required. Include data substantiating that products to be furnished comply with requirements of the contract documents. Include images of similar cabinets/ flat files.

B. Lock specifications must be reviewed/ approved by Owner. Provide product data sheets and information for review. Coordiante keying with Owner and provide proposed keying schedule for review. See also section 2.2,0 below.

C. Shop Drawings: Show fabrication, assembly and installation details. Show complete extent of installation layout including clearances, spacings, and relation to adjacent construction in plan, elevation, and sections. Show access to concealed components; assemblies, connections, attachments, reinforcement, and anchorage; and deck details, edge conditions, and extent of finish flooring within area where units are to be installed.

D. Samples: Submit samples, 6" square, of each finish of each component to remain exposed after installation. Prepare samples on metal of same gauge as metal to be used in the work.

E. Warranty: Subit draft copy of proposed warranty for review.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products of one of the following:
   1. Delta Designs Ltd.
   2. Mayline.
   3. Spacesaver.
   4. Staba Arte.
   5. Steel Fixture Manufacturing Company.
   6. Approved equals will be considered.

2.2 PERFORMANCE REQURIEMENTS

A. Design Requirements: See plans and elevations for dimensional requirements.

B. The basis of design for the UCS-21 flat files Delta Design model 5442 with interior drawer dimensions of 50” x 39-3/4” x 2”.

C. The basis of design for the LCS-17 flat files Delta Design model 4736 with interior drawer dimensions of 43” x 33 3/4” x 2”.

D. The basis of design for the modular paintings screen storage unit is Mod-Glider Modular Art Rack System by Spacesaver. See sheet A-647 for custom configurations.

E. The basis of design for the objects art storage cabinets UCS-23 is Delta Design with gasketed doors, adjustable shelves, lockable doors, and glass doors. Approx dims. 48” wide, 36” deep, and 7’-11 1/2” tall. (UCS-23 is beneath a soffit that is 8’-0” AFF).

F. All materials to be examined for “non reactivity” and their use shall be subject to approval in this regard. “No reactivity” as used herein means that the material is chemically stable and does not off gas or physically degrade to produce any of the following: urea formaldehyde, free sulfate radicals, sulfides, free sulfur, cholorides, acetates, chlorine, formaldehyde, oxides of nitrogen, oxides of sulfur, ammonia, organic acids, disodium phosphate, di butyl phalate, acid hardened phenol formaldehyde resins, peroxides, volatile organic compounds, or plasticizers lacking long term stability.

G. All corners to be rounded and all exposed edges to be deburred.

H. Metal finish to be powder coated steel. Standard color White, or other standard color to be selected by NCMA.

I. Warranty: Any and all defects in design, materials or workmanship that may occur within five years of the date of completion shall be remediated at no expense to the Owner.

J. Flat file case construction shall not be less than 18 gauge for sides, top and bottom and back, and 16 gauge for reinforcing structural channels. Case to be fusion welded for rigidity. Top to be watertight.

K. Flat File drawers shall be museum grade, 20 ga steel, full extension, sizes as noted on drawings. Drawer sides shall be formed so as to enclose the bearing surfaces of the drawer and of the case-mounted drawer glides, thus allowing drawer to be removed and handled without danger of soiling hands or drawer contents. The drawer support system will provide for smooth, vibration-free opening and closing of the drawer, and will be so constructed as to eliminate any danger of soiling (with accumulated dust or dirt) of any lower drawer(s) as a result of movement of a higher drawer on its. Drawer fronts to be a formed channel with 2 flush mount handles and label holder. Each drawer will be supported with two case-mounted glides. Each glide will have a heavy-duty ball bearing slide attached Drawers will fit in all cases of like type with a minimum 1/4" space between them. Drawers will have a pair of reinforcing channels spotwelded to the underneath side. Flat file drawers in mobile system to have gang lock or hinge locking device.

L. Shelves: Shelves shall be fabricated of no less than.047" (18ga.) formed down 3/4" in front and down 3/4" in back. They shall support a uniformly distributed load of 200 lbs. with a deflection of 1/4" or less. Each shelf will be supported with two case-mounted brackets. All shelving to be adjustable unless otherwise noted. The brackets will be adjustable vertically in one inch increments without the use of special tools. Shelves shall have a reinforcing channel spotwelded to the underneath side. Shelf case shall be 18 gauge metal at sides, tops, bottoms and back, 16 gauge for load bearing posts.

M. Steel Doors & Gasket System: Provide locking doors on all free standing units unless

otherwise noted. The doors will be a minimum of 1.25" thick with front panels and channels of no less than.047" (18ga.) steel. Locking Handles will be fully recessed and will close the doors firmly against a peripheral gasket and an astragal gasket at the joint between the doors. The gasket will be Silicone. The gasket will be mechanically attached. Hinges will be continuous from the top to the bottom of the door and will allow the door to open a full 180 degrees to lie flat against adjacent cases, and will allow proper operation of drawers when open 90 degrees. Door to have latching via three-point positive engagement at top, bottom and center with lock bars travelling through nylon silencer.

N. Filter Vent: Filter vents will be installed on the inside face of each door to allow fresh air to circulate within the case. These vents will be screened with mesh with openings smaller than 5 mils. Vents will be adaptable for filtering air thru activated charcoal as well as for complete closure.

O. Locks: All cabinets will be provided with high security locks that lock the cabinet securely. Keying type and schedule per Getty Security and Owner requirements. Locks must be approved by Getty. Pending Getty approval, locks may be one of the following:
   1. Medeco High Security UL Listed Cam Lock model 60-1251T, body length 0.620, head thickness 0.183, head diameter 0.865, 3-pin.
   2. Medeco T-Bolt Cam Lock, model 62-80550, Key Retaining- single Key Pull, Key removed in locked position only, 5-pin.

2.3 HARDWARE

A. Drawer Pulls: Provide the following pulls at cabinets and drawers: TYDIX edge pull #SRO style, polished stainless steel finish. Fastening edge of pulls to be fully recessed in doors/drawers.

B. Alternate pulls/ hardware may be submitted for consideration by the Owner.

C. Provide label frames at all flat file drawers.

D. Locks as noted in section 2.2,O above.

2.4 DELIVERY, STORAGE AND HANDLING

A. Follow manufacturer’s instructions and recommendations for delivery, storage and handling requirements.

2.5 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions before fabrication. Indicate verified measurements on Shop Drawings. Coordinate fabrication and delivery to ensure no delay in progress of the Work.

B. Coordinate with GWB and millwork surrounds.

2.6 SEQUENCING AND SCHEDULING

A. Sequence storage furniture installation with other work to minimize possiblity of damage and soiling during remainder of construction period.

B. Schedule installation of specified products and accessories after finishing operations, including painting have been completed.

C. Provide components, which must be built-in, at a time which causes no delays to general progress of Work.

D. Coordinate with millwork shop drawings and fabrication for furniture located in millwork surrounds.

PART 3 EXECUTION

3.1 INSPECTION

A. A. Examine the areas and conditions where storage furniture are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 INSTALLATION

A. A. Install items included in this Section in locations indicated.
   1. Coordinate for installation in millwork.
   2. Coordinate for installation in GWB surrounds. Securely fasten to surround/ seismic blocking.

3.3 WARRANTY

A. Materials and workmanship to be warrantied for a period of five years from date of acceptance by Owner.

3.4 CLEANING

A. Immediately upon completion of storage furniture installation, clear all surfaces and remove surplus materials, rubbish and debris resulting from storage furniture installation. Leave areas in neat, clean condition.

END OF SECTION 105626

SECTION 108113 - BIRD CONTROL DEVICES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes: Bird Control Systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for bird control system and mounting brackets.

B. Product Schedule: For bird control system.

C. Shop Drawings: For bird control systems. Include plans, elevations, sections, details, and attachments to other work.

D. Samples: Full size samples of each type of base with posts attached to wire.

1.4 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For bird control systems to include in maintenance manuals.

1.6 COORDINATION

A. Coordinate Work of this Section with related work.

B. Schedule Work of this Section to occur after adjoining work has been completed, including finishing and installation of sealants.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Bird control system consisting of netting that provides an unstable landing area for sparrows, pigeons, starlings, and larger birds and deter them from roosting in or on the building structure.

2.2 HEAVY DUTY BIRD NETTING

A. See the tables at the end of the Evaluations for a list of manufacturers' products. Use these tables in combination with manufacturers' catalogs or product data to insert series, type, model, and designations of other characteristics.

B. Bird Net System: See Drawings for extents of for each netting system and mounting locations.

C. Components:

D. Net: Heavy Duty UV Stabilized polyethylene net.

E. Material: U.V. stabilized knotted polyethylene net.

F. Flame resistant (270°F melting point).

G. Rot-proof, non-conductive and stable in subzero temperatures.

H. Construction: 6 monofilaments, each 12/1000” thick with U.V. stabilizers added.

I. Break Strength: ISO 1806 protocol mesh tested < 40 lbs.

J. Hardware: Manufacturer’s standard stainless steel.

K. Glue: As recommended by manufacturer.

L. Manufacturers: Basis-of-Design Product: Subject to compliance with requirements, provide ¾” Heavy Duty 12/6 Bird Net 2000; Bird B Gone LLC or a comparable product by one of the following:
   1. Bird-B-Gone LLC.
   2. Bird-X, Inc.
   3. Bird Barrier America, Inc.

2.3 MOUNTING SYSTEMS

A. Solid Steel: For corner attachments use eye bolts with lock nuts. For intermediate attachments, use multipurpose cable brackets with powder actuated fire-in-pins per manufacturer’s installation instructions.

B. Steel I-Beams: For corner attachments, use eye bolts with lock nuts. For intermediate attachments, use the appropriate size girder clips per manufacturer's installation instructions.

C. Sheet Metal: For both corner and intermediate attachments, use multipurpose cable brackets with self-tapping screws per manufacturer's installation instructions.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine the installation area and note any detrimental or hazardous work conditions. Notify contracting officer or inspector of the detrimental work conditions.

B. Do not proceed with installation until conditions are corrected.

3.2 SURFACE PREPARATION

A. Surface should be thoroughly cleaned and free of bird droppings, nesting materials, rust peeling paint or other debris.

B. Remove or repair articles that may damage bird control system after installation, including overhanging foliage, brush and loose parts on the structure.

3.3 INSTALLATION

A. Install bird control system as recommended by the manufacturer. Bird control system shall fit the area to be protected perfectly so pest birds cannot enter the protected area, and so the netting blends with the architecture. Net should be mounted tight to underside of structure, following roof slopes and providing complete enclosure of protected areas.

B. Correct mesh sizes shall be specified to ensure exclusion of the correct pest bird.

C. Bird Control System shall be installed tightly and securely to ensure a long-lasting installation that is visually hard to see.

END OF SECTION 108113

SECTION 108223 - INTERIOR GRILLES AND SCREENS

PART 1 GENERAL

1.1 SUMMARY

A. Work Results:

B. Principal Products:

C. Section Includes:
1. Metal Drapery.

1.2 ACTION SUBMITTALS

A. Samples:
1. Metal Drapery: 12" x 12"Sample.
2. Attachment Hardware: 6" long section.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Ceiling suspension-system members.
2. Structural members to which suspension systems will be attached.
3. Method of attaching hangers to building structure.
4. Carrying channels or other supplemental support for hanger-wire attachment where conditions do not permit installation of hanger wires at required spacing.
5. Size and location of initial access modules for acoustical panels.
6. Minimum Drawing Scale: 1/8 inch = 1 foot (1:96).

B. Product Test Reports: For the metal drapery product, tests performed by a qualified testing agency.

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes to include in maintenance manuals.

B. Warranty Documentation: For all installed materials and attachment devices. .

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same production run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Metal Drapery: Product equal to 5 percent of quantity installed., minimum.
   2. Suspension-System Components: Quantity of each exposed component equal to 5 percent of quantity installed.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver metal drapery, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Do not install metal drapery until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
   1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

B. Existing Conditions: Verify field measurements before fabrication. Show field measurements on Shop Drawings.

PART 2 PRODUCTS

2.1 SOURCE LIMITATIONS:

A. Source Limitations for Ceiling System: Obtain each type of acoustical ceiling panel and its supporting suspension system from single source from single manufacturer.

2.2 METAL DRAPERY (MTL-)

A. Manufacturers: Subject to compliance with requirements, provide Basis of Design product or comparable product indicated on drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.

B. Examine metal drapery before installation. Reject chains that are damaged or discolored.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.

B. Layout openings for penetrations centered on the penetrating items.

3.3 INSTALLATION

A. Suspend ceiling hangers from building's structural members and as follows:
   1. Install hangers plumb and free from contact with fixtures that not a part of supporting structure or of ceiling suspension system.

B. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

3.4 ERECTION TOLERANCES

A. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3 mm in 3.6 m), non-cumulative.

3.5 CLEANING

A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.

B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 108223

SECTION 114000 - FOOD SERVICE EQUIPMENT

PART 1 - GENERAL

1.1 DEFINITIONS

A. The following definitions are intended to clarify the relationships involved in this document and are used as a definition throughout this food service specification.

1. Food Service Equipment Contractor (FEC):

a. The FEC is the party responsible for supplying, delivering (including freight, staging, and local warehousing as required), assembling, setting in place, installing, cleaning, sanitizing, and polishing any foodservice item(s) included in this contract, but not limited to all required materials and labor, pursuant to the guidelines and timelines scheduled and rescheduled by the Owner, Architect and Camacho, Incorporated.

2. Sub-Contractors:

a. The FEC may contract Sub-Contractors to perform any portion of the contract, but the final responsibility for the proper performance of the contract rests solely with the FEC.

3. General Contractor (G.C)

a. The G.C. / Construction Manager (C.M.) has the responsibility for overall installation, scheduling, deliveries, coordination of various trades, rough-in and connection of utilities, including but not limited to all labor and materials for said rough-ins and connections for all equipment in this contract unless otherwise specified, by item, within the equipment data specification sections of this contract.

1) The FEC must coordinate its activities and needs with the G.C. / C.M. in a timely manner so as not to delay the project.

4. Food Service Designer / Consultant:

a. Camacho Foodservice Design and Consulting (Camacho) is the Food Service Designer/Consultant for this project.

5. The FEC is the party responsible for all taxes, tariffs, duties, and/or customs fees and permits where applicable, as may be required.

a. The FEC is contracted by the Owner.

B. N.I.F.C. - Whenever the abbreviation N.I.F.C. is used in this contract, it shall mean the item or items are not part of the Food Service Equipment Contract.

C. The assignments and responsibilities as outlined in this section are subject to change at the Owner/Architect's discretion.

1.2 RELATED DOCUMENTS

A. All drawings, general, special, and/or supplementary conditions, Division 01 00 00, specifications, and related documents apply to this specification. The Foodservice Consultant for this project is Camacho.

1. The Consultant is responsible to the Project Architect and the Owner to ascertain that the FEC complies with all the requirements of this section.

B. All work included under this section is subject to the Architect's provisions covering Invitation to Bid, Proposal Form, Instructions to Bidders, General Conditions, and all other Supplemental General Conditions as may be added.

1.3 INTERPRETATIONS

A. Plans And Specifications

1. The extent of the Food Service Equipment is on the drawings, Equipment Schedule, and Specifications of this Section of Performance Criteria. Each model number includes the code *C013 as a suffix.

    a. This code is known as the Specifier Identification System.
    b. It is not to be removed by the Bidders.
    c. Its purpose is to identify the specifier to the vendors providing the equipment when it is necessary to communicate questions, clarifications, and comments from before the bid award through the final purchase.
    d. It will be used in all correspondence, including fax and e-mail when communicating with Manufacturer representatives and factories.

2. The plans indicate the location of the equipment. Slight changes due to the varying dimensions of equipment and wall construction shall be permitted with approval by the Architect.
3. Conflict in Plans and Specifications where changes, alterations, additions, or deductions are necessary, or where exceptions are concerning sizes, locations, and other details shown on plans, shall be reported in writing for a decision by the Architect.
4. The Contractor shall be responsible for seeing that the equipment can be entered through openings before the doors and walls are finished.
5. Should it appear that the work intended to be described or any of the matters relative thereto are not sufficiently detailed or explained on the drawings or in the specifications, the Contractors shall apply to Camacho / Architect.

6. If any question arises regarding the true meaning of the drawings, specifications, and/or typographical errors, reference shall be made to Camacho / Architect, whose decision shall be conclusive.

    a. In no instance shall a bid be submitted, or any work started with uncertainty.

7. Before doing any work or ordering any materials, the Contractors shall verify all measurements of any work and be responsible for their correctness.

    a. Any differences that may be found shall be submitted to Camacho / Architect for consideration before proceeding with the work.
    b. Extra compensation will not be allowed because of differences between actual dimensions and measurements indicated on the working drawings.
    c. When conflict occurs between or within standards, specifications, codes, ordinances, and working drawings, the more stringent or higher quality requirements shall apply.

1.4 APPLICABLE DOCUMENTS

A. Bidding Documents, Contract Forms, and related materials issued by Camacho, the Project Architect, G.C. / C.M., and the Owner before awarding a contract apply to this section.

B. Architectural, Mechanical, Electrical, and Structural Plans and other Specifications, including all supplements issued thereto and other pertinent documents issued by Camacho, the Project Architect, C.M., and/or the Owner, are a part of these Specifications and the accompanying Food Service Equipment Plans and shall be complete within every respect.

1. All the above included herewith will be issued separately by C.M. or is on file at Camacho / Project Architect’s office and shall not relieve the Contractors of responsibility or be used as a basis for additional compensation due to omission(s) of Architectural, Structural, Mechanical, Plumbing or Electrical details from food service equipment documents.

1.5 BASE BIDS AND SUBSTITUTIONS

A. Substitution of Materials and Equipment:

1. Where equipment is specified by the name of the Manufacturer and model number, it is intended that the designated name and number represent a standard of quality and is not intended to restrict competition in any way.
2. The Architect reserves the right to accept or reject each proposed substitution, and such decision shall be final and binding upon all parties.

    a. All proposed equipment substitutions shall be submitted to the Architect ten (10) days before the date of the bid, and all substitutions must acquire pre-bid approval.

b. Furthermore, these specifications intend to produce a set of Foodservice Equipment to meet the Owner's needs.

3. Among the primary requirements are sanitation, ready accessibility for cleaning, low-cost maintenance and operation, strength, and ruggedness. Any construction detail or evasion of any of the specification requirements shall cause rejection.
4. Plans and specifications are based on the products or systems of the first-named Manufacturer.

    a. Any modifications and substitutions other than the first name that require changes in plumbing, mechanical, or electrical shall be coordinated and paid for by the FEC, as noted in this section.

5. Acceptance of proposed substitution is entirely at the discretion of the Owner or their Representative and subject to the following qualifications:

    a. Equal in quality of material used in structural strength and details of construction.
    b. Equal in performance, mechanically, and productivity.
    c. Equal in the finish or characteristics permitting specified finish to be applied.
    d. Availability of replacement parts and maintenance service.

6. The bid price for each proposed substitute shall include all money required to incorporate the substitute into the project.

    a. Later requests for additional monies for substitutes will not be considered.

B. Bidders recommending substitutions are cautioned to examine the Plumbing, Mechanical, And Electrical Plans and Conditions at the building site to determine if such substitution will require changes in Plumbing, Mechanical, and Electrical connections already planned or installed.

1. If the proposed substitutions require such changes, the Bidder shall include the cost of the same in their bid and call it to the attention of the Architect by including a descriptive notation in the request for approval.

C. Bidders shall engage a firm experienced in manufacturing Food Service Equipment similar to that indicated for this project and with a record of successful in-service performance.

D. It is required that all "Fabricated Special" items of equipment such as food service units, tables, sinks, countertops, etc., described in the following Specifications other than by name and catalog numbers, be manufactured by a Foodservice Equipment Fabricator who has the Manufacturing Plant, Personnel, And Engineering Facility to properly design, detail and manufacture high-quality foodservice equipment, NSF and UL approved.

1. The Manufacturer shall be subject to the approval of the Architect and Owner.
2. All work in the above category shall be manufactured by one Manufacturer and shall be of standard unit assembly and of uniform design and finish.
3. The Manufacturer of this equipment must be able to show that they have, for the past seven years, been engaged in the manufacture of and distribution of equipment as required by the Contractor as their principal product.

4. All submittals for proposed substitutions must be submitted with equipment data. sheet for each item.

    a. The data sheet shall consist of the:

        1) Project Name
        2) Project Architect
        3) Foodservice Consultant,
        4) Firm submitting, the item number,
        5) Manufacturer,
        6) Manufacturer's model number,
        7) A complete written description of what is to be provided.
        8) Accessories and options list of what is to be provided:
        9) Finishes, dimensions, utility requirements as provided (i.e., GAS: NAT or LP, Electrical: Voltage/Phase and Amps, Plumbing/Mechanical: Water/Sewer, etc.) as well as the type of connection.

E. The data sheet shall have a blank space (3-1/2"w x 5"h) in the lower right corner of the sheet for stamping, etc.

1. This information must be submitted not less than ten (10) days from the bid due date to be considered as an alternate.

F. Where substitutions are made by the FEC with the written approval of Camacho / Project Architect, the FEC shall be responsible for and pay all costs of any consequential modifications that may result from the substitution.

G. If the FEC decides to submit an alternate Manufacturer and receives a written response from Camacho / Project Architect accepting this change, then all resulting expenses incurred in the changes or additions to the Food Service Equipment work, as well as other Contractor’s work, shall be the sole responsibility of the FEC and shall be considered as part of the base bid with no additional compensation permitted.

H. Accepted substitutions will be noted in an addendum issued by the PA/E. No other substitutions and deviations from the primary Manufacturer will be permitted subsequent to the date of the Bid Opening except by specific Change Order and only with sufficient cause.

1. The approval of substitution does not approve, relieve, or change the Contractors’ responsibilities as outlined herein.

I. Task / Responsibility

1.	Project Coordination:	GC/CM*
2.	Permits (Health Department):	ARCH/OWNER
3.	Construction Schedule:	GC/CM/ARCH
4.	Coordination of Inspections/ (Foodservice):	FEC

5.	Demolition of Kitchen Equipment (If required):	FEC
6.	Wall Repairs (If required):	GC/CM
7.	Rough-In Drawings:	FEC
8.	Rough-Ins (Required Service to Utility Connections) Noted on FEC Rough-In Drawings):	PC, EC & MC
9.	Tile Work:	GC&CM
10.	Stainless Steel Wall Panels:	FEC
11.	FRP (Wall Panels):	GC/CM
12.	Furnishing of Specified Equipment:	FEC
13.	Liquor Dispensing System (If required):	FEC
14.	Beverage Raceway and Conduits (If required):	FEC
15.	Beer Systems (If required):	FEC
16.	Bulk CO2 System (If required):	FEC
17.	Indirect Wastes Extend from Equipment to Drains:	PC
18.	Installation of Foodservice Equipment	FEC
19.	Final Utility Connection:	PC/EC/MC
20.	Utility Interconnections:	PC/EC/MC
21.	Trim and Seal Foodservice Equipment	FEC
22.	Clean-Up of Foodservice Areas:	FEC
23.	Walk-In Refrigeration Floor Insulation:	FEC
24.	Walk-In Refrigeration Sub-Floor and Finished Floor:	GC/CM
25.	Walk-In Refrigeration Lighting	FEC Furnished, EC Installed
26.	Ceilings:	GC&CM
27.	Floor Troughs:	FEC Furnished, PC Installed
28.	Floor Sinks, Floor Drains, Funnel Floor Drains:	PC
29.	Mop Sinks, Hand Sinks:	PC (Unless otherwise specified)
30.	Bar Scupper Trough:	(Located by FEC) MWC
31.	Foodservice Sneeze Guards:	FEC (Unless otherwise Specified)
32.	Insulation of Piping:	PC

*Or as specified in general specifications as prepared by the Architect.

1.6 INTENT

A. It is the intent of the Contract Documents for each/every item and component to be complete with all required devices and standard features necessary for that item and component to function properly.

B. It is the intent of the Contract Documents for each/every item and component to function and perform in a manner equal to the Primary Manufacturer's intent. FEC is required to notify Camacho / Project Architect in writing of any or all discrepancies or omissions of any components prior to submitting the bid.

C. Failure of the FEC to report any discrepancies and/or omissions prior to submitting his bid shall not relieve the FEC of his responsibilities for providing complete, functioning, workable systems in full accordance with the intent of the Contract Documents.

1.7 RESPONSIBILITY MATRIX

A. The following represents the basic Contractor responsibilities for this Project. The assignments and responsibilities outlined in this section are subject to change at the Owner/Architect's discretion.

B. Abbreviations:

1. CM - Construction Manager
2. GC - General Contractor
3. FEC - Food Service Equipment Contractor
4. PC - Plumbing Contractor
5. EC - Electrical Contractor
6. MC - Mechanical Contractor
7. MWC - Millwork Contractor

PART 2 - SCOPE OF WORK

2.1 WORK INCLUDED

A. Work required under this section consists of providing all necessary services, tools, equipment, material, and labor required to provide the continuous installation (the term installation shall mean the complete installation including, but not limited to, the delivery of all food service equipment items and necessary components to complete with transportation charges and taxes prepaid by the FEC to the job site's location) as designated on the food service equipment plan, uncrated, erected, set in place, leveled and made ready for final connection, by G.C. to Plumbing, Gas, Electrical and Steam utilities, as specified in Divisions 22 00 00 and 26 00 00 of Performance Criteria and properly anchored and trimmed as may be required.

B. FEC is to deliver all parts and components to be built into cast-in-place concrete and masonry in ample time for inclusion in the concrete and masonry work. Furnish necessary setting plans and instructions, oversee the installation of all parts in the masonry and concrete, and be responsible for the correctness and accuracy of the location and installation.

C. FEC to provide holes, ferrules, and stainless-steel chases on equipment for pipes, drains, electrical outlets, conduits, and equivalent items as may be required to coordinate and accommodate the installation of the Food Service Equipment in connection with the work of other contractors.

D. FEC to provide the materials, labor, services, and incidentals necessary for completing these sections of work, including but not limited to adhesive, caulking, Sealing, trim strips, chases, corner guards, corner trims, and closure panels.

E. FEC will provide items and components hereinafter specified and shown on plans, completely assembled, or erected in locations indicated, ready for final connections to service by the respective trades.

1. The labor and material(s) required for final connections are the responsibility of G.C. / C.M.

F. FEC will provide and install fasteners, flashing, trim strips, filler panels, can't strips, and caulking and Sealant where required to complete the installation.

G. All roof, wall, and floor assemblies, including finishes (as specified herein), penetrations, openings, curbs, platforms, and dunnage pursuant to the requirements of the food service, ventilation and refrigeration items are to be provided and installed by the G.C. unless specified otherwise.

H. All roof, wall, and floor assemblies, including finishes (as specified herein), penetrations, openings, curbs, platforms, and dunnage pursuant to the requirements of the food service, ventilation and refrigeration items are to be provided and installed by the G.C. unless specified otherwise.

I. Keep premises clean and remove from the site all crates, cartons, and other debris resulting from the work. Leave all areas "broom cleaned" and all equipment items and furnishings "construction clean". Final cleaning, sanitizing, and polishing of all equipment items and furnishings shall be done by the FEC.

1. Further, it is the FEC's responsibility to provide protective coverings for all equipment items delivered to the job site during construction.

2.2 RELATED WORK OF OTHER CONTRACTORS

A. Division 01 0000 - General Construction

1. All floor assemblies, including finishes, openings, depressions, sleeves, curbs, and bases.
2. All wall and partition assemblies, including finishes, openings, recesses, sleeves, furring, and backing.
3. All ceiling assemblies include finishes, openings, soffits, access panels, fire separation, and sleeves.
4. All roof assemblies, including finishes, openings, curbs, platforms, and dunnage.
5. All structural supports or grounds for hanging or fastening Food Service Equipment and assemblies as may be described in this section.
6. G.C. will provide on-site storage trailer(s) and security for the Owner's existing and FEC-provided Food Service Equipment for this project, if applicable.

B. Division 22 0000 – Mechanical

1. Sanitary and grease-laden drainage systems.

a. Final plumbing connections include mounting drains, water, gas, and steam supply systems, as required.
b. Faucets, pre-rinses, hoses, and piping from the point of connection on equipment to building plumbing systems and interconnections between equipment components. Install all hoses from utility raceways to connection points on equipment.

2. Grease traps.

a. Indirect drain line runs from equipment items to the nearest floor drain or floor sink as required.

3. Gas, water, steam pressure-reducing valves, and all other fittings, as required,
4. Gas shut-off valve(s) as required for ventilator fire suppression system and gas regulators on individual pieces of gas-fired equipment by the Manufacturer's recommendations are to be provided by the FEC and installed by the G.C.
5. FEC will furnish faucets with nipples, elbows, supply lines, valve stops, drains, splash-mounted vacuum breakers, etc., for each equipment item as specified herein. Items to be installed by the G.C.
6. All exposed plumbing concerning Food Service items must be chrome plated.

C. Indirect wastes shall be chrome plated and drip over and into floor drains and sinks. Where drains and supply lines run under equipment, provide the proper support from the underside to eliminate interference with cleaning and maintenance.

D. When the Exhaust Hood Systems are to be furnished and installed by Division 22000 and are not to be included as part of the FEC work, Division 22000 shall provide and install the gas valve in the main supply line serving the cooking equipment to shut off gas service to the cooking equipment in the event of fire system actuation.

1. This work must be coordinated with the FEC, NFPA 17A, and NEC.
2. This specification shall further provide this work.

E. Division 23 0000 - H.V.A.C.

1. G.C. to provide and install all necessary components as may be required for the Exhaust/Make-Up Air System(s) and Condensate Exhaust Air System, including but not limited to the Fans (unless provided by the FEC), Ducting, Gas shut-off valve(s), Curbs, Penetrations, Dampers, Controls, and Switches unless otherwise specified herein.
2. G.C. will provide and install the required rated chase(s) and other separations as may be required.
3. G.C. will provide and install all heating, ventilating, and air conditioning systems except as specified in this section.

F. Division 26 0000 – Electrical

1. All electrical distribution, lighting, and power systems except otherwise specified in this section.
2. Final electrical connections and interconnections, including labor and materials from point of connection on equipment to building electrical systems and required interconnections between equipment components.
3. All electrical materials, including wire, conduit, over-current protection, main switches, safety cut-outs, shunt-trip breakers, disconnect switches, lighting control devices, surge protectors, uninterruptible power units, and controllers.
4. Shunt-trip breakers, contactors, and all conduits for shut down of electrically operated cooking equipment and ventilation equipment as required for the ventilator fire suppression system.
5. Empty conduit systems for refrigeration system, as specified and shown on food service drawings.
6. Empty conduit system for point-of-sale system, as specified and shown on food service drawings.
7. Empty conduit for fire suppression system, as specified and shown on food service drawings.
8. EC shall furnish all electrically operated portable and movable equipment items with factory-installed 3-wire or 4-wire Heavy-duty insulated cords with a grounded plug with one leg of the cord grounded to a conductible portion of the item's frame.
9. Furnish and install switches and disconnects within the equipment, contractors, and combination starters with fused disconnects, controls, and equivalent items necessary for the equipment's safe and proper operation and compliance with all N.E.C. and local AHJ requirements.
10. All switches, disconnects, and control devices shall be safely accessible without crossing or over any hot and hazardous equipment items.
11. FEC to secure cords to the underside of the equipment on portable and movable equipment to allow ea.se of maintenance or as required by the Owner.
12. Install all electrical cord sets provided by the FEC as part of the food service equipment and install all cord sets from utility raceways to connection points on equipment.
13. When the Exhaust Hood Systems are to be furnished and installed by Division 220000 and are not to be included as part of the FEC work, Division 260000 shall furnish and install automatic power disconnect devices (shunt trip breakers or definite purpose contactors) with interlock to fire system micro switch, to shut off all power below the hood (including control voltage) in the event of fire system actuation.

    a. This work must be coordinated with the FEC, NFPA 17A, and NEC.

G. All Plumbing, Steam, Electrical, and Ventilation Work required in connection with this section shall be done by the other Contractor unless specifically called for in the itemized Equipment Specifications.

H. Work of others shall include but not be limited to exhaust fans and ductwork associated with the ventilation of the hood, roughing-in to points indicated on the Mechanical, Plumbing, and Electrical plans, and final connections from rough-in locations to various pieces of equipment requiring such connections and the supplying of all necessary materials and labor for this work except as specified or scheduled.

I. Tile adhered to bases below the specified equipment is by others.

J. Refrigeration work to be performed under this Section, except for electrical and plumbing connection to compressors, blower coils controls, etc., provided by others, is as listed in the itemized specifications.

K. Others shall furnish and install all line and disconnect switches, safety cutouts, control panels, fuse boxes, or other electrical controls, fittings, and connections. Starting switches shall be provided by the Food Service Equipment Supplier as specified under General Specifications.

1. Those starting switches furnished loose as standardized by Food Service Equipment Supplier Manufacturers (other than fabricated items) shall be installed and connected by others.

L. Any sleeves or conduit required for refrigeration and tubing lines shall be furnished and installed by others. Refrigeration alarm system connection by others.

M. Plumbing and Steam Fitting Trades shall confirm that all lines are flushed free of foreign matter before connecting equipment.

N. The Electrical Sub-Contractor shall make all final connections to the equipment shown on Drawings or specified.

1. The Electrical Sub-Contractor shall be responsible for checking all equipment to determine where starters, contractors, switches, and other items are required.

O. The Plumbing Sub-Contractor shall make all final connections to the equipment shown on Drawings or specified, and it shall be the responsibility of the Plumbing Sub-Contractor to provide traps, tailpieces, fittings, water piping, floor drains, shut-off valves, and all other necessary fittings.

1. The Food Equipment Supplier shall provide faucets, all lever waste drains, and hose reels with mixing valves to the Plumbing Sub-Contractor for connection and installation.

P. The Mechanical Sub-Contractor shall make final connections to the equipment shown on Drawings or specified, and it shall be the responsibility of the mechanical sub-contractor to provide and install necessary ventilation facilities of sufficient capacity to operate the equipment.

1. Mechanical work to be done by the Food Service Equipment supplier is listed in the itemized equipment specifications.

Q. The General Contractor shall provide openings and passageways sufficient to sustain the weight of the Food Service Equipment Supplier, and they shall provide openings and

passageways of sufficient size to permit the delivery and erection of the equipment to their respective locations without dismantling.

1. Coordination of these openings is critical for the equipment installation.
2. The General Contractor shall provide a depressed floor for drain grates and a walk-in cooler/freezer when noted.

2.3 RELATED WORK BY OWNERS

A. Install Owner furnished equipment in accordance with the installation section of this document unless otherwise specified herein.

2.4 REFERENCES

A. The Drawings indicate the desired basic arrangement and dimensions of the equipment. Minor deviations may be substituted for approval provided basic requirements are met and no significant rearrangement of service to the equipment is required to affect the proposed alteration.

1. These deviations shall be made without expense to the Owner.

B. Operational and functional tests of the installed equipment are required. Defects or deficiencies shall be corrected to the satisfaction of the Architect or Owners at the Contractor's expense.

1. Consult the Mechanical and Electrical Connections Drawings and their accompanying Specifications to determine additional work requirements and shall cooperate with all trades to ensure a satisfactory installation.

C. The electrical wiring of the equipment's motors, motor starters, switches, and thermostats shall be an integral part of the unit, containing a junction box for the connection of electrical service.

1. All motor-driven equipment shall have thermal overload and underload protection.

D. Furnish a suitably mounted control switch or starter of proper type per UL or ETL Codes on each motor-driven appliance or electrically heated unit.

1. All controls mounted on vertical surfaces of fixtures shall be set into recessed die-stamped stainless-steel cups or otherwise indented to prevent damage to the control switch.

PART 3 - QUALITY ASSURANCE

3.1 FOOD SERVICE CONSULTANT

A. The Owner has employed Camacho, Incorporated as the Food Service Consultant.

B. The "chain of command" shall be the Food Service Equipment Contractor, the General Contractor / Construction Manager, the Project Architect (PA / E), the Food Service Consultant, and vice versa in all matters concerning the Food Service Equipment.

3.2 EQUIPMENT

A. Equipment, except for "buy-out" or standard catalog items, shall be fabricated in a plant bearing the name of a recognized Food Service Equipment Fabricator.

1. This fabricating firm shall have been in business for at least five years, with a suitable organization to design, engineer, manufacture, deliver, and install the equipment.

    a. Said installation shall be by local union conditions when applicable. Such firms shall be able to refer to other successful installations of similar operating conditions.
    b. Further, the Fabricator shall be able to UL classify and list the items that they fabricated.

B. Under no circumstances shall the FEC sublet any portion of the fabricated equipment to any Sub-Contractor without Camacho’s written approval.

C. All fabricated food service equipment with inter-wiring and pre-wired equipment and refrigeration shall be manufactured by a Fabricator that can UL list (or other applicable AHJ listing) and classify their work.

3.3 LABOR

A. Experienced mechanics shall perform all labor in this type of work. All work on the premises shall be done at such time as to promote the proper conduct of the project. Provide a competent on-site superintendent to supervise the work and to provide other trades with the information necessary to maintain proper conduct and timely completion of the work.

3.4 FOOD SERVICE EQUIPMENT CONTRACTORS

A. Pre-approved Food Service Equipment Contractors include:

1. Trimark Foodservice Equipment Supplies & Design 708-496-1700
2. Boelter Foodservice Design, Equipment & Supply: 800-263-5837
3. Mobile Fixture 251.342.0455 / 800.345.6458

4. Johnson-Lancaster 727.796.5622

3.5 CODES, LAWS, AND STANDARDS

A. General Requirements

1. The equipment furnished under this section will be supplied by one Food Service Equipment Contractor.
2. Permits and Certificates:

    a. All laws, codes, ordinances, and regulations bearing on the conduct of the work as drawn up and specified shall be complied with, and all notices required given. For any work upon which an inspection certificate by local authorities or any governing body is required, such Inspection Certificate or Certificates shall be obtained and paid.
    b. Certificates of acceptance or completion as required and issued by the State, Municipal, or other authorities shall be procured and delivered to the Owners. The Owners may withhold payments that are due or that may become due until the necessary Certificates are obtained and delivered to the Owners.
    c. All safety devices and all accessories required to comply with regulations and governing codes shall be provided, regardless of whether specified or called for in the following technical divisions of the equipment list portion of this Section of Specifications.

3. Applicable Manufacturing Standards:

    a. Special fabrication items shall be manufactured in compliance with Standard No. 2 of the National Sanitation Foundation Testing Laboratory and shall bear the NSF Seal of Approval.

    b. Equipment pieces shall be manufactured in compliance with Standards No. 3, 4, 5, 6, 7, 8, 12, 13, 18, 20, 21, 25, 29, 35, 37, 51, 59, and 61, where applicable, of NSF Testing Laboratories and bear the Seal of Approval. This shall include any pending standards, which shall become applicable when the equipment is delivered.

    c. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations of the following:

        1) National Fire Protection Association (NFPA)
        2) NFPA 96-Installation of equipment for removal of smoke and grease-laden vapors from commercial cooking equipment, current edition.
        3) NFPA 13 - Installation of Sprinkler Systems, current edition.
        4) NFPA 17 - Dry chemical extinguishing systems, current edition.
        5) NFPA 17A - Wet chemical extinguishing systems, current edition.
        6) NFPA 70 - National Electric Code.
        7) NFPA 96 - Ventilation Control and Fire Protection.
        8) National Sanitation Foundation (NSF).
        9) Underwriter's Laboratories, Inc. (UL), including but not limited to UL-300
        10) National Electric Manufacturers Association (NEMA)
        11) American Gas Association (AGA)

12) American Society for Mechanical Engineers for Steam Equipment
13) National Fuel Gas Code (NFGC)
14) State Board of Health Regulations (10-D-13)

d. All electrically operated and heated equipment, fabricated or otherwise, shall conform to the latest standards of the National Electric Manufacturer's Association (NEMA) and the Underwriter's Laboratories, Inc. (UL or ETL), where applicable standards have been set up by that agency, or otherwise, such as to be acceptable to authorities having jurisdiction.

1) This shall include any pending standards, which shall become applicable at the time the equipment is delivered.

4. Electrically heated and motor-driven fixtures shall be for the current shown in the Mechanical and Electrical plans.

a. These items of equipment shall have mounted motor starters, switches, and controls.
b. All shall be required for each fixture or complete section of a fixture or as specified.

5. Gas burning equipment to be designed for operation with the type of gas furnished and approved by the American Gas Association.

a. The label or listing of the American Gas Association shall be accepted as conforming to this requirement.
b. Equipment installation shall conform to the standards set forth by the American Gas Association and the National Plumbing Code.
c. Where required, all gas equipment shall be furnished with a safety pilot, one hundred percent safety cut-off, and automatic pilot ignition.

6. NFPA Codes 13, 17, 17A, and 96 standards shall be complied with for the exhaust system. Provide all safety devices on all accessories required to comply with regulations and governing codes.

3.6 MISCELLANEOUS REQUIREMENTS:

A. Plumbing:

1. Provide chrome-plated faucets specified and certified to NSF standard 61, Section 9. All backsplash-mounted faucets shall be provided with double male nipples with locknuts for rigidly securing the faucet to the backsplash. The nipple-locknut assembly shall be provided under this section as part of the faucet.
2. Provide all wastes incorporated in the custom-built fabricated Food Service Equipment. Provide all waste with a chrome-plated tailpiece.

B. Electrical:

1. Interwiring of Food Service Equipment between heating elements, switches, starters, thermostats, outlets, motors, and solenoids shall be complete to the junction box, terminal box, or disconnect switch (should Specifications call for disconnect switch to be provided in this section).
2. Provide grounded receptacles specified under Item No. of detail Specifications or as shown on the Contract Drawings. All receptacles are to be as specified and furnished with stainless steel faceplates.
3. All electrically operated equipment is to be per the codes, regulations, and laws of the state where the project is located.

C. Safety:

1. All Food Service Equipment provided under this Contract shall be manufactured and installed in conformance with the Williams-Steiger Occupational Safety Health Act of 1970.

D. Coordination:

1. Coordinate with the project's plumbers and electricians to assist in cutting or knocking out holes in the stainless-steel tables, counters, and cabinet bases to allow for efficient utility connections to equipment.

E. The Contractor shall be held responsible and liable for all changes or variances in Performance Criteria without written authorization from the Architect for said changes or variations.

PART 4 - SUBMITTALS

4.1 GENERAL REQUIREMENTS

A. FEC shall verify all field measurements on the job site to ensure proper fitting of all equipment. Within four (4) weeks after the G.C. / C.M. has been awarded a contract by the Owner, the FEC is to electronically submit pdf format to the Architect for tentative approval, all dimensioned rough-in drawings, equipment submittal brochures, fabrication, and Manufacturer's shop drawings in one package.

1. Partial submittals will not be accepted and will be stamped revise / resubmit.
2. The reproduction of original contract documents is not acceptable for use as a submittal.

B. After the initial review of submittal data, revise and resubmit only the datasheet, coversheets, or rough-in and shop drawings that have been modified or changed, the entire submittal is not required for a resubmission.

1. After two resubmissions, the FEC may be charged a fee for Camacho's continuous re-evaluation.

a. This will be billed as an additional service.

C. Field measurements required to size and place Food Service Equipment are to be verified with on-site field dimensions.

1. Do not rely on or measure drawings for actual on-site dimensions.
2. Dimensions shall be taken from the actual structure, giving consideration to any Architectural, Structural, or Mechanical discrepancies that may occur during the construction of the building.
3. Field dimensions shall be taken at the earliest opportunity so as not to delay deliveries.

a. Notify the Foodservice Consultant of the earliest date and time.

4. FEC shall be responsible for the proper fit of all equipment furnished under this Section of the Contract.

a. Gaps over ¼" wide are not acceptable.

4.2 SAMPLES

A. Provide all samples of materials requested by Camacho / Architect for test purposes or comparisons.

B. Samples used for testing shall not be used on the work without the written approval of Camacho / Architect.

C. Samples may be retained by Camacho, the Project Architect, or the Owner as a matter of record without any additional compensation to the Contractors.

D. Owner to provide all samples as required to FEC to ensure proper sizing of dispensing equipment hereinafter specified (cups, glasses, dishware, etc.).

4.3 BROCHURES

A. Prepare and submit equipment cut sheets showing all Manufacturer's data sheets describing equipment as specified. Include items listed as "Future, Existing-Relocate, or Owner Furnished."

1. The item numbers shown on the submittal shall be the same as those shown on the contract documents. The equipment cut sheets are to be provided using Auto Quotes format or similar, including coversheets for each item.

2. Where a piece of equipment is used and specified with multiple item numbers assigned, the first item is to be provided with a cover sheet and datasheet. For additional identical items, provide cover sheets only.

B. Provide the following information on the coversheets:

1. Project name.
2. FEC name.
3. Foodservice Consultant name.
4. Item Number.
5. Equipment description.
6. Quantity.
7. Written specification/description of equipment provided.
8. Accessories.
9. Utilities.

C. Record copy brochures, which shall be delivered at the demonstration and start-up, are to be bound in booklet form in three-ring binders.

4.4 ROUGH-IN AND MECHANICAL CONNECTION DRAWINGS

A. FEC is to prepare and submit rough-in drawings showing all utility rough-ins for kitchen equipment items, including items listed as "Future, Existing-Relocate, or Owner Furnished" (min. scale of ¼" =1'-0").

B. Drawings to indicate the size and location of all utilities, floor depressions, raised bases, and wall openings for equipment.

C. The item numbers shown on the rough-in drawings shall be the same as those on contract documents.

D. Drawings shall be dimensioned to the stub up or stub out, not to the connection on the equipment.

1. The FEC shall be responsible for conforming to these conditions with equipment and connections thereto.
2. In the event rough-in has been completed before the award of the Contract, the FEC shall thoroughly investigate, and field verify the provided rough-in locations and provide equipment to suit building conditions.
3. FEC will provide an equipment floor plan with itemized equipment, including all utility loads.

E. Electrical rough-in plans will be dimensioned to indicate the above-finished floor (AFF) height. 90° plug heads where available.

1. Verify all NEMA plug types, cords, and equipment connection lengths.

    a. Lengths are to be of adequate distance for outlets available and to allow equipment to be placed as shown on contract documents.

2. Show convenience receptacle locations.

F. Plumbing rough-in plans are to be dimensioned to indicate the above-finished floor (AFF) height.

G. Special conditions plan indicating dimensions and locations of:

1. Raised pads.
2. Wall openings for pass-through equipment.
3. Floor Trough Depressions
4. Walk-In depressions
5. Floor drains.
6. Wall backing.
7. Recessed or wall-mounted control panels.

H. Provide a refrigeration system schematic piping plan indicating line size, elevation, trap locations, and all specified components required for the refrigeration system installation.

1. The plan is to include equipment and parts provided by the Refrigeration Equipment Manufacturer.
2. Verify that refrigeration sizing is proper for line lengths determined by actual field conditions.

4.5 SHOP DRAWINGS

A. Custom stainless-steel equipment, walk-in cooler/freezer and refrigeration, exhaust hoods, dishwashers, scullery equipment, and other shop drawings shall be provided on drawing sheets of equivalent size as contract documents.

B. All shop drawings shall be detailed and fully dimensioned to a minimum scale of 3/4" = 1' -0". Elevations and sections must be detailed to a minimum scale of 1-1/2" = 1' -0").

1. Show all materials, gauges, and construction methods, including relation to adjoining and related work when cutting or close-fitting is required.
2. Show all reinforcements, wall plates, backing, anchorage, and other work needed for a complete installation of fixtures.
3. Show the item number and quantity required for each detail. Show adjacent walls and columns and identify countertop equipment with item numbers and descriptions.
4. Show all components that are included in fabricated equipment.

5. For equipment with load centers (panels), indicate total electrical calculations, including circuits. Provide an electrical diagram for on-site electricians.
6. Provide color, pattern, or finishes for laminated, fiberglass, paint, or stain for approval by the Architect/Owner.

C. Shop drawings showing the plan and elevations shall be 3/4" = 1'-0" scale, and sections shall be 1-1/2" = 1'-0" scale covering all fabricated items.

1. Drawings are to show the location of equipment to be coordinated with each item, such as boosters mounted to the underside of the dish table and garbage disposers under sink compartments.

D. Omissions and discrepancies on approved drawings shall not relieve the FEC of providing items as specified and shown on Contract Drawings.

1. The verbiage 'By Others' is not acceptable and should be defined by Trade.

E. Fabrication details must identify all metal gauges, hardware, trim, electrical parts, special fitting, and other components by Manufacturer's name and model number.

F. Foodservice Submittal Documents are to be signed by the FEC to indicate they have been reviewed and coordinated with submittals by Electrical, Plumbing, Mechanical, Millwork, or other Trades, and meet all contract requirements.

G. Foodservice Submittal Documents, which are not stamped and approved by the FEC, will be returned as "NOT REVIEWED."

1. The FEC will be required to resubmit after review, as stated above.

H. Verify size and weight information of the service ware (glasses, plates, trays, cups, etc.) for self-level dispensing, ware washing, and mobile equipment with the Owner.

I. Verify that carts, racks, and dollies can fit into fixed equipment (roll-in refrigeration, combi ovens, walk-ins, counters, etc.).

4.6 CHECKING

A. Checking of rough-in drawings, shop drawings, details, and equipment by Camacho is for design concept only and does not relieve the FEC or G.C. / C.M. of responsibility for compliance with design drawings, details, and specifications, verification of utilities with equipment requirements for conformity and location and verification of all dimensions of the equipment, building conditions or reasonable adjustments due to deviations.

B. Drawings shall be prepared on the Food Service Equipment Contractor's sheets and by his employees.

C. Drawings of any part thereof created by photograph, paste-up, or other methods using Camacho and Architect drawing(s) and details are a violation of federal copyright laws and will be returned for re-submittal.

D. FEC will assume responsibility for the proper locations and sizes of sleeves, conduits, and depressions for the various equipment requirements.

E. FEC is responsible for making multiple field inspections to verify the rough-in locations prior to the pouring of concrete, the closing of walls, etc.

1. FEC shall compensate other trades for any relocation of rough-ins.

4.7 HANDLING AND STORAGE

A. Protect metal and millwork products finish from damage during shipping, storage, handling, installation, and construction of other work in the same spaces.

1. Wrap and crate each item of equipment as needed for protection from damage.
2. Cover exposed stainless steel and millwork surfaces with a self-adhesive protective paper recommended by the metal and millwork Manufacturer, and do not remove until work is installed and ready for cleaning and start-up.

4.8 SCHEDULING

A. Schedules and Reports:

1. Establish the earliest and latest job site delivery dates for FEC-provided equipment.
2. Delivery of Owner furnished equipment for installation shall take place at a time to be determined by Owners, but not necessarily during regular working hours.

4.9 WORKMANSHIP AND GUARANTEES:

A. Equipment shall be delivered in an undamaged condition upon completion. All workmanship and labor shall be of the best in their respective fields and skilled mechanics of the trades involved.

B. All equipment specified in this section shall be guaranteed for one year from substantial completion. If, at any time within this warranty period of one year, any equipment is found to

be faulty due to poor workmanship or inferior or defective materials, replace said pieces or correct each defective part at no cost to the Owner.

C. Refrigerated items shall have an additional four-year warranty on the compressor unit. Only labor charges after the first year shall be paid on an extended compressor warranty.

D. At the end of the first year, assign extended warranties to Owners on equipment that have more than one year's warranty from the Manufacturer.

PART 5 - PRODUCTS

5.1 PREFABRICATED EQUIPMENT

A. Where reference is made to a Manufacturer's model number and Manufacturer specifications, it is intended that the specification of that primary Manufacturer is utilized as a basis of design and specification standards and has become a part of these Specifications and Documents.

B. Items and parts of any item referred to by Manufacturer's name and model number shall be furnished complete with all standard equipment of the Manufacturer used as a basis of design and specification standards plus all extras and modifications hereinafter specified and required.

C. The same Manufacturer shall produce similar type items and similar type components to facilitate maintenance and convenience and reduce the Owner's spare parts inventory.

D. Modifications to the standard equipment specified shall be made by the original Manufacturer when required.

5.2 PRODUCT OR MANUFACTURER APPROVAL

A. The product of the primary Manufacturer named, where more than one Manufacturer is listed, was used for the basis of design and specification standards, and sets the standard of quality, appearance, performance, aspect, capacities, and function for that item.

B. Only products of listed primary Manufacturers will be accepted unless requests for substitutions and submittals of alternate Manufacturers are submitted to Camacho in accordance with stated conditions.

1. When Alternate Manufacturers are approved as a Manufacturer, each item from an alternate Manufacturer must be submitted to Camacho for approval/rejection.

    a. Refer to Section 1.5, Base Bids and Substitutions for more information.

2. Other Manufacturers must modify their products, if necessary, to comply with the quality, physical, and functional characteristics of the Primary Manufacturer and must be approved by Camacho.

C. All Manufacturers listed may not be able to supply an equipment item, under the specifications, as standardized by the Primary Manufacturer whose name and model number were utilized herein as the basis of the design standard for this project, in which case, the listed alternate Manufacturers may elect to modify an item to meet the specifications.

5.3 CONSTRUCTION

A. General

1. The materials, components, and techniques describe the construction of items of the Food Service Equipment.

    a. Deviation and extra refinements peculiar to any one item will be described and indicated.

2. It is required that all custom/fabricated items in these plans and specifications, other than by Manufacturer name and model number, shall meet the requirements of the American Iron and Steel Institute Designations and be constructed of Type 304 stainless steel, and be manufactured by a Fabricator that can UL list and/or classify their own products.

    a. Type 430 Stainless steel (straight chrome - no nickel) shall not be acceptable for custom-built fabricated equipment.
    b. All sheets shall have a natural mill finish of not less than commercial No. 4 on the exposed side and not less than No. 2 on the unexposed side.
    c. All stainless steel shall be stretcher leveled, with a thickness of:

        1) 14 Gauge - Not less than 0.075 Inch.
        2) 16 Gauge - Not less than 0.063 Inch.
        3) 18 Gauge - Not less than 0.050 Inch.
        4) 20 Gauge - Not less than 0.038 Inch.

B. Welding shall be of electric arc or oxy-acetylene gas.

1. Welding shall be done with a rod of the same material and full penetration of the entire length of the joint.
2. Welds to be flat without buckles, voids, or imperfections.
3. All welds shall be ground flush with adjacent surfaces, conditioned to eliminate slippery surfaces.
4. All shear cuts or bends that tend to open the surface of the metal shall be rewelded, ground, and polished.
5. All edges are to be ground and filed to eliminate sharp or rough edges.

C. When stainless steel sheets have the grain running in different directions, the sheets all be so jointed, and welds run and finished in such a manner as to make the sheets appear as one continuous product.

D. Gauges:

1. All Gauges of metals, where specified, shall be manufactured to the standards set forth by the U.S. Standard for Sheet Metal.
2. Unless specified, no material shall be finished lighter than 20 gauge for custom-built fabricated equipment.

E. All exposed surfaces of equipment shall be free of bolts, screws, and rivets.

1. Wherever these fasteners are used they shall be an approved type constructed of stainless steel.

F. All tops, sink bowls, drain boards, and troughs are to be sound-deadened.

1. Sound-deadening to be no less than 1/8 inch thick and allowed to dry thoroughly before being finished with two coats of paint.
2. Component Hardware, Model Q75-1366 NSF approved gray latex sound deadener for brush or spray application,
3. Model Tacky Tape for worktop application between top and hat channel reinforcing.

5.4 TABLE AND COUNTERTOPS

A. All tops are to be fabricated with 14-gauge, Type 304 stainless steel one-piece construction with all seams, butt joints, and corners welded, ground, and polished smoothly, resulting in a one-piece top without joints and crevices.

1. All intersections of three (3) or planes shall be coved.
2. Tops to be free of all deflection, reinforced with 1” x 5” x 1” inverted 14-gauge stainless steel channels with 1” flanges, stud welded to the underside of tops in a vermin-proof manner.
3. Two (2) channels running lengthwise under tops up to 30” wide (tops over 30” wide, channels spaced maximum of 30” on center).
4. One (1) channel running from front to rear at legs and/or not more than 6’-0” on center.
5. All intersections of channel reinforcing shall be fully welded and sealed.

B. Tops with open edges shall have 1-3/4” on the bull-nose edge or 2-inch rolled down the edge with all exposed corners rounded on a 2-1/2-inch radius or bull-nose corner.

C. Where the table borders on or is adjacent to the wall, there is to be a 4” high backsplash with a 1-inch turn back to the wall with welded enclosed ends unless otherwise specified.

1. See Drawings for typical details.

D. Sleeves: Where legs, standards, pipes, or pipe chases come through a work area. or tabletop, they shall pass through 3” high stainless-steel sleeves, with the periphery fully welded and polished to match adjacent surfaces.

E. Where the tops are adjacent to walls, columns, equipment, enclosures, etc., they shall have a splash.

1. The splash standard shall be by the Specifications.

F. Where holes are punched through the top to accommodate equipment, said holes should be ferruled and provided with a rubber grommet.

G. Ends adjacent to similar equipment shall have a common end post.

H. Bases shall be open-type construction, 1-5/8" O.D. stainless steel tubular legs spaced 60” on center, fitted with stainless steel bullet type, adjustable feet, and enclosed conical gussets unless otherwise specified.

1. Cross bracing shall be 1-5/8" O.D. stainless steel tubular members fully welded to legs as required.
2. When cross bracing is furnished with stainless steel flanged feet, they shall be sealed and secured to the finished wall and/or stainless-steel cabinet bases with stainless steel lock washers and nuts.

    a. Flanged feet are to be set in a bed of FDA-approved clear silicone Sealant prior to securing to the finished wall and/or equipment.
    b. Providing a bead of Sealant after securing feet is not acceptable.

3. Where undershelves are provided, they shall be constructed of 16-gauge stainless steel, fully welded to tubular legs, ground smooth,10” above the finished floor.

    a. The braces shall be constructed to form rectangular, or "H" frames, and at least one brace shall be welded to each leg.

4. Gussets shall be stainless steel NSF-approved cylindrical with a setscrew.

    a. Leg gussets are to be welded to the underside of tables, reinforcing channels, and underside of sinks.
    b. Gussets shall be Model No. A20-0206 was manufactured by Component Hardware Group Inc., and comparable stainless-steel gussets were manufactured by Standard-Keil Hardware Manufacturing Company, United Showcase, Component Hardware, and Kason Food Service.

5. Feet shall be stainless steel adjustable bullet shape, fully enclosed, tightly fitting the leg.

a. Provide 1-inch up and down adjustment from the central position, at no time exposing any threads.
b. Adjustments are to be easily made by hand without the use of tools.
c. For counters and cabinet bases, the feet shall be the same as for above. feet having comparable quality to Component Hardware Group, Inc. and Kason Food Service are approved.

6. Freestanding sinks shall be supported on legs and feet as specified, with bracing from front to rear only.

7. When legs are furnished with stainless steel flanged feet, they shall be sealed and secured to the finished floor with stainless steel threaded anchor bolts.

a. Anchor bolts are to be set 3” into the finished slab and extended to a minimum height above the finished floor as required for securing equipment.
b. Equipment to be fastened down with stainless steel lock washers and nuts.

8. Flange feet are to be set in a bed of FDA-approved clear silicone sealant prior to securing it to the finished floor.

a. Providing a bead of sealant after securing feet is not acceptable.

5.5 CASTERS:

A. Plate Type:

1. Provide stainless steel swivel plate casters.

a. Provide 5-inch Ply-Loc gray wheels with 1-1/4" tread, Zerk grease fittings and seals, and a 250-pound capacity.
b. Front casters to have brakes manufactured by Component Hardware Model No. CMPI- 5RPB or equal manufactured by Jarvis Casters or Colson Caster

B. Stem Type:

1. Stem Type: Provide stainless steel swivel stem casters.

a. Provide 5-inch Ply-Loc gray wheels with 1-1/4" tread, Zerk grease fittings, and Seals and a 250-pound capacity.
b. Front casters to have brakes manufactured by Component Hardware Model No. CM54-5RPB or equal manufactured by Jarvis Casters or Colson Caster.

C. All ends and edges that are rough or sharp shall be filed and ground to a safe, smooth finish before delivery to the job site.

5.6 TABLE WITH BAKER TOP

A. The top is to be constructed of 3” thick maple hardwood with a 4” x 1” stainless steel channel subframe connected to the base.

B. Table base, cross bracings, undershelves, splashes, etc. shall be provided as hereinbefore noted under Section 6.3.2 Table and Counter Tops and hereinafter specified.

5.7 TABLE WITH POLY TOP

A. The top is to be constructed of a 1-1/2” thick white anti-bacterial cutting surface with a 1” X 5” x 1” stainless steel channel subframe connected to the base.

1. Top to be removable for cleaning.

B. Table base, cross bracings, undershelves, splashes. etc. shall be provided as hereinbefore noted under Section 6.3.2 Table and Counter Tops and hereinafter specified.

5.8 ENCLOSED BASES

A. Closed base fixtures shall have rigid welded frames enclosed on all sides except where shelves and/or doors are required.

1. The cabinet body shall be constructed of 16-gauge stainless steel.

B. Tops shall be cross-braced with 1-1/2" X 1-1/2" X 1/8" galvanized angles spaced at 2'-0" O.C. maximum, reinforced with 14-gauge stainless steel 1" X 5" X 1” channels wherever necessary for rigidity.

C. Leg channels shall be 1" X 5" X 1” 14-gauge stainless steel channels spaced 4'-0" O.C. maximum on the bottom to receive legs.

D. Closed base fixtures shall be mounted on casters or stainless-steel adjustable counter legs, as indicated on plans and/or item specifications.

1. Legs for the cabinet base shall be 8 inches high, including feet.

E. Shelf supports shall be continuous 1-1/2" X 1-1/2" X 1/8" galvanized angles welded to the frame. There shall be no exposed galvanized steel channels or supports.

F. Utility chases shall be 18-gauge stainless steel with removable access or service panels.

1. Partitions shall be 18-gauge stainless steel.

G. Exterior panels shall be FRP plastic laminate as a part of millwork or stainless steel with vertical grain as specified in item specifications.

H. Non-exposed panels adjacent to walls or closed base fixtures shall be 18-gauge stainless steel.

I. Interior shelf units shall be 16-gauge stainless steel, edges turned up 2" at sides and rear, down 1-1/2" at the front, and where shelves butt together, corners to be welded.

1. The shelf is to be fixed and constructed by details (removable 2'-0" max. sections to be provided when specified for ease of removal and cleaning).

J. Compressor compartments shall have removable louvered panels with 2" X 3/4" X 18-gauge stainless steel double channel perimeter frames, 1/2" X No. 16 Niles flat stainless steel expanded metal guards, 14-gauge galvanized steel compressor mounting channels, and enclosure panels.

K. Recessed areas shall be lined with 18-gauge stainless steel.

L. Plastic laminated panels shall have a 3/4" thick exterior plywood base veneered on all exposed sides and edges with Wilsonart, Formica, or Westinghouse Micarta plastic applied or laminated per the Manufacturer's recommendations.

1. Plastic laminated panels shall be without joints.
2. Grain and pattern material, color, pattern, and/or texture shall be as approved by the Project Architect.
3. The trim shall be 18-gauge stainless steel with vertical grain.
4. Stainless steel and brass trim shall have flush welded joints.

M. Control panel recesses, valve handle recesses, and individual control knob recesses shall be 18-gauge stainless steel.

1. Depth must be sufficient to prevent the control from protruding past the face of the body panel.

N. Legs shall be provided as specified.

1. Weld to framing members of the counter.
2. Provide 3-1/2" square 12-gauge galvanized steel top plate welded on legs bolted onto equipment.
3. Secure with four (4) 1/4-20 stainless steel bolts.

O. Cashier's stations shall have 18-gauge stainless steel liners, cash drawer liners, and 14-gauge stainless steel 30º sloping footrests with 10" wide level tops.

5.9 COLD PANS

A. The interior shall be 16-gauge stainless steel one (1) piece construction with all corners coved on a 3/4" radius pitched to a 1" stainless steel drain fitting welded to the shell.

1. Pipe drain line to the bottom of the cabinet.

B. Exposed exteriors shall be 18-gauge stainless steel.

C. Concealed exteriors shall be 18-gauge stainless steel.

D. The entire pan shall be insulated with 2" thick urethane foam.

1. Provide a non-toxic, high-impact plastic breaker strip around the entire opening to prevent condensation.

E. Refrigerated cold pan coils shall be 1/2" O.D., type K copper tube with wrought copper fittings and silver soldered joints.

1. Space runs of the coil at 1-1/2" O.C. parallel to the long axis of the cold pan bottom and sides and solder in place.
2. Runs are equally spaced at 4" O.C., securing the coils to the pan.
3. After the coils are secured to the pan, cover the entire bottom and sides with thermal mastic and apply waterproof covering.

5.10 UNDER COUNTER REFRIGERATORS / FREEZERS

A. Refrigerators/freezers shall be all metal construction with no wood.

1. The outer shell is to be constructed with 18-gauge stainless steel and be fully welded to form a vapor-proof Seal.

2. The inner shell is to be no less than 20-gauge stainless steel with coved corners pitched to a 1" stainless steel drain fitting welded to the shell.

a. The drain should be located as close as possible to the blower coil.

3. The entire compartment shall be insulated with 2" thick approved urethane insulation on all sides, top and bottom.

4. Provide a non-toxic, high-impact plastic breaker strip around the entire cabinet opening perimeter.
5. Provide the same heaters in freezer doors.
6. A vinyl magnetic gasket shall be installed around the full perimeter of the cabinet opening for a positive seal.

B. Flush mount a 2-1/2" diameter dial thermometer in the face of the cabinet.

C. Interior shelving to be stainless steel wire shelves mounted on adjustable clips providing four-point support.

1. Shelves shall be removable for cleaning.
2. Provide one (1) bottom shelf and one (1) intermediate shelf unless otherwise specified.

D. Doors shall be fabricated 1-1/2" thick with approved foam urethane insulation.

1. Doors shall be 18-gauge stainless steel double pan type construction with flat sides for edge-mounted hardware secured to internal tapping strips in the door body.
2. Provide each door with self-closing cam lift hinges.
3. Door(s) to actuate an incandescent shatter-proof light.

    a. Light to be mounted so as not to interfere with storage space.

E. Drawers, if specified, shall be mounted on stainless steel self-closing roller-bearing tracks with positive stops.

1. A vinyl magnetic gasket is to be provided around the entire perimeter of the drawer front for a positive Seal.
2. Drawer fronts are to be 18-gauge stainless steel double-pan construction with urethane insulation.
3. Provide condensate-proof heating wires in the cabinet mullion and the entire perimeter of the drawer opening.

F. The refrigeration system shall be properly sized to maintain refrigerated food products at 38º to 40º Fahrenheit and frozen food at -10º Fahrenheit.

G. Where under-counter refrigerators are specified, and the top is to have an opening to receive stainless steel pans.

1. The openings shall be die stamped.

H. The top shall be provided with an 18-gauge stainless steel double pan removable cover with urethane insulation.

1. Cover to be furnished with gasket, stainless steel lift handle, and lid cover bracket assembly, as manufactured by Component Hardware, Keil, Grant, or Knape.

5.11 UNDER COUNTER REFRIGERATION SYSTEMS

A. Evaporator coils for fabricated under-counter refrigerators/freezers shall be blower-type coils and installed for accessibility and replacement.

B. All temperature controls, expansion valves, sight glass, and solenoid valves will be installed during manufacturing and mounted for ea.sy adjustment and service.

C. Refrigeration circuits shall have automatic expansion valves, dual high-low pressure switches, high-pressure line sight glass, and line vibration eliminators.

D. Evaporator coils shall have the condensate drain line routed to and furnished with a condensate evaporator, as manufactured by Component Hardware, Keil, Grant, or Knape.

1. Provide wall-mounting brackets if required.

E. Each condensing unit shall have a separate control switch with a pilot light and an engraved phenolic plastic identification sign.

1. Refrigeration system shall be properly sized to maintain refrigerated food products at 38° to 40° Fahrenheit and frozen food at -10° Fahrenheit.

F. Refrigeration lines are to be Type ACR copper with cast fittings assembled by silver soldering joints.

1. Silver soldering or silver brazing shall be done in the presence of nitrogen (oil pumped) in the tubing to prevent. oxidation and scale formation.
2. The refrigeration system shall be evacuated three (3) times to a maximum pressure of 500 microns and flushed between each evacuation with nitrogen.

G. Refrigeration lines shall be insulated with Armstrong Armaflex insulation.

H. Refrigeration systems shall operate on Freon R448A in high and medium temperatures and Type 448A in low-temperature applications.

I. On remote refrigeration systems, all refrigeration piping is to be pre-piped at the time of manufacturing and routed to one (1) central location ready for a one (1) point hook-up by the Refrigeration Contractor.

5.12 REFRIGERATION

A. All refrigeration systems (piping, hangers, compressors, evaporators, installation, etc.) shall comply with Division 22000 and be factory-installed by a properly licensed heating and Air Conditioning Contractor.

1. The Contractor must have three (3) years of experience with projects of this size.

B. Upon completion of testing, the Manufacturer shall provide the Architect with a written certificate of acceptance, showing that all quality standards have been met, and the complete system is operating properly.

C. The Manufacturer shall provide start-up and one-year service and maintenance contracts in addition to a regular one-year guarantee for self-contained refrigeration systems.

D. The refrigeration system shall be pre-packaged, pre-engineered, factory assembled, air-cooled, remote refrigeration system.

1. Verify the location of the system.
2. Provide weather-proof housing.

E. The system is to be complete with all refrigeration equipment and accessories required to make a complete refrigeration system that will maintain temperatures indicated.

F. The system is to be provided with low ambient controls consisting of all required condenser fan controls, thermostat time clocks, and crankcase heaters.

G. Refrigerator and freezer condensing units and coils shall be as called for in the itemized specifications and as shown on the plan.

H. Refrigeration units shall be provided with single-stage compressors with air-cooled condensers operating at such speed within the recommended range of suction and discharge pressures for walk-in coolers and freezers and with required BTU specifications.

1. Each compressor unit shall be equipped with a compressor, large pump down the capacity receiver with two shut-off valves, liquid line drier, sight glass, suction, and high-low pressure control.
2. Provide all new units of the same Manufacturer, factory assembled, to operate with Refrigerant R-448 for the cooler and R-448 for the freezer, 100ºF ambient air, capacities selected on 16 hours running time basis.

I. Hook-up of room thermostat and liquid line solenoid valves (for pump down cycle operation) and refrigerant lines (insulated as required) are to be provided by FEC.

1. All electrical interconnections and control wiring between blowers and compressors are to be provided by the Electrical Contractor.

2. FEC to provide Manufacturer's literature and data to Electrical Contractor in coordinating this work.

J. System to be pressure evaluated (both high and low side) with dry nitrogen at 300 psi.

1. After evacuating the system and charging it with refrigerant, test piping with a halide torch and prove tight under actual operating conditions.

K. Refrigeration units shall be provided with single-stage compressors with air-cooled condensers operating at such speed within the recommended range of suction and discharge pressures for walk-in coolers and freezers and with required BTU specifications.

L. Each compressor unit shall be equipped with a compressor, large pump down the capacity receiver with two shut-off valves, liquid line drier, sight glass, suction, and high-low pressure control.

M. Refrigerant Piping and Accessories:

1. FEC to extend refrigerant lines from condensing units to evaporators until completely hooked up and ready for operation.
2. The system shall be complete and sized to conform to current ACRMA standards. Refrigerant, drain, and condensate water piping shall be Type "L" hard drawn copper ACR refrigerant tubing with long radius wrought copper solder joint fittings.
3. Provide wall sleeves, hangers, and escutcheons as specified for typical piping. Make-up joints with high-temperature silver-solder (SIL-FOR or equal) suitable for 300 psi working pressure.

    a. Pass dry nitrogen gas through the pipe while joints are soldered.

4. All refrigerant suction lines shall be insulated with UL fire and smoke-rated nominal 3/4" thick flexible foamed plastic, closed-cell pipe insulation equal to Rubatex R-180-FS.
5. Insulation shall have a "k" factor of not more than 0.26 at 70 degrees F mean temperature and a water vapor transmission rate of 0.1 per-inch or less.

    a. Slip onto the pipe before erection and Seal butt joints with #373 adhesive.
    b. Insulate sweat fittings with miter-cut pieces of insulation the same size as on adjacent piping.
    c. Insulate screwed fittings with sleeved fitting covers fabricated from miter-cut pieces of insulation according to the Manufacturer's sleeving size recommendations, overlap, and seal to the adjacent pipe insulation.

        1) Paint all insulation with two coats of Rubatex 374 white finish.

6. Condensate drain lines are the same as refrigerant suction lines except for 3/4" thickness.

N. Sleeves:

1. FEC to provide drawings showing locations and sizes of all necessary sleeves for refrigeration lines, drain lines, etc.
2. Actual penetration through building walls and floors is to be provided by the General Contractor.

O. Freezer drain lines are to be wrapped in electric heater cable to prevent freezing of condensate in drain lines.

1. All drain lines to exit compartments, as shown on the plan.
2. Secure approval of drain line routing from the Architect prior to installation.
3. The freezer is equipped with an electric defrost unit complete with a timer and built-in thermostat to return systems to the freezing cycle and delay the start of the circulating fan until the heat in the coil has been removed.
4. Timer to stop the defrost cycle in case of thermostat failure.
5. Extend drains from coils in copper tubing through walls to drip over and into a floor drain.

P. Control Panel:

1. The package shall have factory mounted and pre-wired control panel complete with interlocked main fused disconnect, compressor circuit breakers, contractors, and time clocks wired for single-point electrical connection.
2. The Electrical Contractor shall provide and install main power lines to the panel and use wire harness wiring for control and defrost heater between the defrost clock and the refrigeration fixtures, all in accordance with the wiring diagram and local codes.
3. The temperature for each unit shall be controlled by means of a thermostat wired to actuate a solenoid valve in the liquid line, with the compressor operation controlled by the low-pressure cutout switch.
4. The thermostat and low-pressure controls shall be adjusted to maintain the room temperatures as specified.

Q. Service Contract to Cover Guarantees:

1. Emergency Refrigeration Service shall be placed with a dependable local refrigeration company maintaining 24-hour service for the life of guarantees and warranties.

R. Pipe Rack:

1. Compressors shall be furnished with the Manufacturer's standard factory-assembled rack unless otherwise specified.
2. Rigidly mount compressor unit motors on the unit or cast base to effect quiet operation.

S. Provide an electrical phase protector.

5.13 DISH TABLES AND SINK SECTION TOPS

A. Tops, troughs, sinks, and back and end splashes shall be 14-gauge stainless steel, integral all welded construction. Tops shall be reinforced with 1”x5”x1” inverted 14-gauge stainless steel channels. Edges shall be constructed per details, 3” high. Back and end splashes at walls, per details, 8” high, 2” return on 45 degrees, 1” turn down at the wall. Top shall slope to dish machine, sinks, troughs, cones, and drainers a minimum of 1/4” per foot with backsplashes and table edges remaining level. When the tabletop attaches to the dish machine, turn it down into the machine and anchor it securely, using only stainless-steel fasteners. The front edge and rear splash at the dish machine are to be watertight and welded closed. All sinks, disposer cones, sumps, troughs, or chutes shall be integrally welded with a top to give a one-piece appearance.

B. Bases shall be open-type construction, 1-5/8" O.D. stainless steel tubular legs, fitted with stainless steel bullet type, adjustable feet, and enclosed conical gussets. Cross-bracing shall be 1-5/8" O.D. stainless steel tubular members welded to legs as required.

C. When legs are furnished with stainless-steel flanged feet, they shall be sealed and secured to the finished floor with stainless steel threaded anchor bolts. Anchor bolts are to be set 3” into the finished slab and extended to a minimum height above the finished floor as required for securing equipment. Equipment to be fastened down with stainless steel lock washers and nuts. Flange feet are to be set in a bed of FDA-approved clear silicone Sealant prior to securing them to the finished floor.

1. Providing a bead of Sealant after securing feet is not acceptable.

D. When cross bracing is furnished with stainless steel flanged feet, they shall be sealed and secured to the finished wall and/or stainless-steel cabinet bases with stainless steel lock washers and nuts. Flange feet are to be set in a bed of FDA-approved clear silicone Sealant prior to securing to the finished wall and/or equipment.

1. Providing a bead of Sealant after securing feet is not acceptable.

5.14 DOORS AND REMOVABLE PANELS

A. Metal doors shall have 18-gauge stainless steel exteriors and interiors. form 1-1/2" X 90-º edges on all sides and welded corners. Rear panels must slip inside front panels and form a double pan assembly with tight joints.

1. Doors and panels are to be easily removable without tools and constructed per details.
2. All doors are to be provided with locking hardware with stainless steel face No. P20-0490 Component Hardware, Keil, Grant, or Knape.

B. The insulation between panels shall be 1-1/2” rigid fiberglass. Secure to both panels where hardware and other screw fastenings are required.

C. Metal doors shall have 12-gauge steel tap-in plates welded to the inside of panels where hardware or other screw fastenings are required.

D. Sliding door tracks shall be No. 1357 Series Keil, Component Hardware, Grant, or Knape. Secure with 1/4-stainless steel bolts. Sliding door roller assemblies shall be No. 1358-1212-1000 Keil, Component Hardware, Grant or Knape, and Vogt. Sliding and hinged door pulls to be full grip, stainless steel No. P46-1012 Component Hardware, Keil, Grant, or Knape.

E. Hinged doors to be hung on two (2) stainless steel lift-off type hinges No. R74-800RH and R74-8000LH Component Hardware. Doors are to be fitted with fabricated integral full-grip horizontal stainless-steel pulls. Doors to be furnished with flush mounted, concealed type, magnetic catch No. M35-1000 or M35-2000 Component Hardware. For doors measuring more than 24” wide, furnish additional catch at the bottom of doors. For all hardware, Keil, Grant, or Knape are acceptable.

F. Louvered doors shall be constructed the same as the door except the center section shall be provided with 18-gauge stainless steel fabricated louvers tack welded flush with the door surface.

G. Removable panels shall be constructed the same as the door and in accordance with details.

5.15 SINKS

A. Construct sinks of 14-gauge stainless steel forming corners with a 3/4" radius, both horizontal and vertical. Sink sizes established on the drawings by Camacho shall be inside measurements.

B. Provide double-wall partitions between sink compartments with 3/4" radius corners, 3/4" radius top edge, integrally welded in place, ground smooth and polished. Fronts, bottoms, and backs of multiple sinks shall be one piece with no overlapping joints and/or open crevices. The bottom of each sink shall be creased to the center and fitted with a lever-operated rotary waste drain with a strainer plate, chrome-plated tailpiece, and overflow pipe.

C. The rotary waste drains shall be set into a 1/2" deep recess assuring complete draining. Overflows shall be fitted in the back of the sink to maintain a constant water level 1" below the sink’s top edge.

D. Where sinks occur in tables, sinks are to be integrally welded and polished as above.

E. Provide all required holes for faucets, vacuum breakers, chemical supply lines, etc.

5.16 SINKS (DROP-IN TYPE)

A. Construct sinks of 14-gauge stainless steel forming corners with a 3/4" radius, both horizontal and vertical, and a 1-1/2” wide perimeter flange.

1. Sink sizes established on the drawings by Camacho shall be inside measurements.
2. The bottom of each sink shall be creased to the center and fitted with a lever-operated rotary waste drain with a strainer plate, chrome-plated tailpiece, and overflow pipe.
3. The rotary waste drains shall be set into a 1/2" deep recess assuring complete draining.
4. Overflows shall be fitted in the back of the sink to maintain a constant water level 1" below the sink’s top edge.

5.17 DRAWERS

A. Drawers shall be constructed per detail.

B. Drawer liners shall be 18-gauge stainless steel; 20”x20”x5” deep removable insert pan No. S81-2020 for tool drawers; 20”x20”x10” deep No. S83-2020 for bread drawers, as manufactured by Component Hardware.

1. Pans to be easily removable without removing the frame or un-tracking the drawer.

C. Supporting drawer frame shall be 14-gauge stainless steel welded channel.

D. Drawer faces are to be 18-gauge stainless steel double wall construction fully welded with insulation between. Face to be welded to drawer supporting frame.

E. Drawers furnished to be fitted with fabricated integral horizontal full grip, stainless steel pulls per details.

F. All drawers shall be provided with adjustable replaceable rubber stops.

G. Drawers are to be enclosed in 16-gauge stainless steel housing under open base tables to make them vermin-proof.

H. Drawer slides shall be Component Hardware No. S52 Series, 14-gauge stainless steel slides mounted on 14-gauge stainless steel supporting channel frame fitted with stainless steel ball-bearing wheels.

1. Slides to be of a self-closing type of sufficient length to allow drawer liner to be removed without removing slides.
2. The drawer shall support a minimum of 150 pounds capacity in a fully opened position.

I. The drawer shall have keyed, locking hardware, stainless steel faced No. P30-4700 Series as manufactured by Component Hardware.

J. Anti-Bacteria, NSF approved cutting board to be Chef's Edge with Microban 18"x24" with 4"x1" handle slot as manufactured by C&K Manufacturing or approved equal.

1. Cutting board to be mounted on 14-gauge stainless steel channels.

5.18 DRAINER PANS

A. Drainer pans shall be constructed of 14-gauge stainless steel welded integral with tops.

B. Drainer pans shall be a recessed integral part of the top with cove corner bodies that slope to drains per details.

1. Drainer with the disposer.
2. Drainer with removable strainer for pot and pan sinks without disposer.
3. Drainer with removable strainer for countertops.
4. Drop-in drainer with removable strainer for countertops.
5. Drainer with removable strainer secured with tamper-proof fasteners.

C. Drainer pans recess fitted with strainers located below each glass filler, urn faucet, beverage dispenser, ice dispenser, or draft beer spigot.

D. Drip pan strainers shall be No. 1580 Series Keil Heavy-duty stainless steel drip plates with three (3) 3/4" wide louvers X 90% total strainer length, two (2) No. 1586-1010-1318 Keil finishing rings in each section, 1" X 90-º angle edges, and welded corners.

1. Component Hardware is an approved equal.
2. Drip pan strainer shall be constructed in equal length, removable sections.

5.19 ELECTRICAL

A. Electrical conductors shall be run in rigid conduit to a junction box on the exterior the of fixture and have a minimum 12" pigtail.

B. Flexible conduit shall not be used except for motor connections.

C. Motors shall have a flexible conduit vibration section, at least 12" long and not over 24" long, with a ground wire running through the conduit.

D. Wiring in prefabricated and/or manufactured equipment shall be U.L. approved construction by the Equipment Manufacturer.

1. Wiring in custom-built equipment, areas, locations, or compartments where the temperature may exceed 150 degrees F. shall be of Type A1 moisture-proof range and appliance lead wire with nickel conductors, with an approved insulation and braided cover.
2. Wiring in custom-built equipment, areas, locations, or compartments that will be exposed to moisture or high humidity shall be Type THW-75C machine wool wire with copper conductors and thermoplastic insulation.
3. All internal wiring in custom-built equipment shall be terminated in one (1) junction box that is accessible for connection and service.
4. All wiring shall be permanently marked by color coding. A permanent wiring diagram shall be attached to each piece of equipment. Conductors connected to terminals shall have T & B Sta-Kon rings.

E. Conductors connected together shall have Buchanan Crimp connectors including splash caps and insulators.

F. Conductors of multi-wire branch circuits shall have two (2) wire circuits with one (1) black and one (1) white: three (3) wire circuits with one (1) black, one (1) white, and one (1) blue.

1. Neutral conductors shall be white.
2. Grounding conductors shall be green.

G. Electrically operated portable equipment shall have a cord and plug.

1. Service cords shall be Type SJO with grounding conductor securely fastened to the body or frame of equipment.
2. Plugs shall be grounding type with service cord grounding conductor connected to grounding blade.
3. Receptacle grounding contacts must be clearly labeled with instructions for the electrician to connect this terminal or contact the branch circuit grounding conductor.

H. Electric motors shall have control switches for starters.

I. Electric motors and electrically heated equipment directly connected to the building electric system shall have a positive disconnect that will open all conductors and meet NEMA standard KS-1-1957 for Type H.D. switches.

J. Combination starters and disconnects installed in a single NEMA enclosure shall have the same type of components as individual starter switches, fused switches, and breakers.

K. Starters, transformers, and disconnects shall have NEMA enclosures in dry areas and watertight NEMA 4 or 5 cast enclosures in wet areas.

L. Each light fixture or group of light fixtures in the same system shall have No.1251-1 Hubbell or equivalent Arrow-Hart or Pass and Seymour double pole press switch.

M. All equipment specified or detailed where light fixtures are specified shall be LED.

1. All LED lighting fixtures furnished as part of the food service equipment contract shall have a CRI value greater than 90 each, dimmable when specified.
2. LED fixtures are to be provided and installed by the FEC.

N. Recessed receptacles and switches with pilot lights shall be stainless steel finish, Model R73-1210 and R-73-1212 by Component Hardware, or approved equal, specified with stainless steel faceplates.

O. Two (2) or more receptacles of the same voltage in the same equipment shall be pre-wired to a common junction box for one (1) final connection, providing the total load does not exceed 30 amps.

1. All pre-wiring shall be done in rigid conduit with all wires color-coded and tagged.

P. When counters are specified to be pre-wired to circuit breaker panel(s):

1. FEC shall provide 'Square D' breaker panel(s), or approved equal, sized as required to meet the equipment loads as well as local and state codes.
2. Each panel shall be mounted within the counter cabinet body behind the hinged stainless-steel door as located and shown on the plan.
3. Panel(s) to have individual breakers as required and main breaker; all utilities to be on separate breakers.
4. All wires shall be tagged, numbered, color-coded, run through an approved conduit, and located in cabinet utility chase. All breakers shall be labeled, and the unit shall be supplied with wiring schematics.

Q. For counters requiring delivery in sections for re-assembly in the field, each section the of counter shall be pre-wired and wire ends supplied with snap-lock type connectors ready for reconnection in the field.

1. Providing rolls of wiring with a counter is unacceptable.

R. The counter shall be complete, and ready for one (1) final connection to each circuit breaker panel by Division 16.

5.20 HANGER ASSEMBLIES

A. Framing members for hoods, hoists, or other equipment with a live load of 500 pounds or weighing over 500 pounds shall be 2" X 2" X 1/4" steel angles spaced at 36" O.C. maximum.

B. Hangers for piping, refrigerant lines, and beverage dispenser conduit shall be Power-Strut metal framing with Series PS-300 channels, Series PS-10 spring clamping nuts, 1/2" diameter hanger rods, brackets, beam clamps, conduit clamps for each pipe or line and fasteners.

C. The horizontal runs of two or more pipes or lines shall have Power-Strut trapeze hanger and/or surface mounting assemblies spaced at 60" O.C. for lines smaller than 3/4" O.D., 72" O.C. for lines 3/4" to 1-1/2" O.D. for lines 1-5/8" O.D. or larger.

D. Horizontal and vertical runs adjacent to building walls shall have surface-mounted assemblies with the same spacing and trapeze assembly.

5.21 ELEVATED SHELVES

A. Shelves shall be constructed of 14-gauge stainless steel, as applicable.

B. Shelves shall be level and plumb, underbraced same as top hereinbefore specified when exceeding 48” in length.

5.22 OVERSHELVES

A. Over shelves shall be fabricated of 16-gauge stainless steel with edges rolled down or up and supported as specified.

B. Over shelves mounted on tabletops shall be supported by 16-gauge stainless steel tubular legs. Legs are to be securely fastened to the tabletop with fasteners similar to Model No.1655000272, manufactured by Kason Food Service or an approved Manufacturer.

5.23 UNDERSHELVES

A. Undershelf section constructed of 16 gauge type 304 stainless steel with rear and ends turned-up 2", front edge turned down 1-1/2" with 3/4" return on 45 degree angle, closed ends, reinforced with stainless steel hat channel on underside of shelf, notched and fully welded to legs, ground and polished to a uniform finish.

5.24 WALL SHELVES

A. Wall Shelves shall be fabricated of 16-gauge stainless steel and the same construction as "Over shelves." Secure brackets to the wall with stainless steel screws with expansion shields. Brackets shall be spaced on a maximum of 4 feet on center.

B. Wall shelves shall be supported on the table's extended rear legs with cantilevered supports of 14-gauge stainless steel flag brackets.

5.25 TROUGH / DISPOSER INSTALLATION

A. Fit end(s) of the trough with one (1) chrome-plated water inlet, Component Hardware No. K36-6000, with gate valve control. Minimum connection to unit 1/2”. Additional water inlets shall be provided as shown in the drawings and as specified in the itemized specifications.

B. Each sump, cone, or sink with a disposer mounted in the bottom shall be fitted with a water inlet as specified above, located to direct waste into the disposer with a minimum splash.

C. All connections shall be made in accordance with the Manufacturer’s recommendations (FEC shall show schematics on rough-in drawings).

D. Entire trough/sump combination shall be integral with top to give a one-piece appearance; designed to transfer waste into disposer without accumulation or restriction.

E. Trough/sump to be provided with integral stainless-steel silver saver adjacent to disposer entrance.

1. Silver-saver to be furnished with drain, per Detail DET-37.02

F. Furnish 14-gauge stainless steel, flush, removable disposer cover with perimeter edge turned down 1/2” at sump/cone.

5.26 STAINLESS STEEL CHANNEL BASE FRAMES.

A. Constructed of 12-gauge stainless steel channels.

B. Stainless steel channel base to be constructed of u-shaped 2" x6"x2” 12-gauge type 304 stainless steel fully welded, to be secured to equipment cabinet base and finished floor with 3/8" stud bolt at each corner and 4'-0" o.c. with expansion anchor in the concrete slab.

C. Provide cross bracing and notch to suit floor drains and mobile equipment as required.

D. Channel base is to be sized to meet equipment requirements to ensure proper clearances, toe kicks, and utility access relative to equipment specified and provided, disassembled, and reassembled in the field, set in place prior to setting equipment in place.

E. Channel base to be epoxy coated and/or finished as specified by the project Architect or interior designer or as required by the authority having jurisdiction, secured, and sealed to the floor.

F. Channel base to be filled with concrete by General Contractor with a sealed top (as required) and cove base. PSI rating of concrete is to be verified by General Contractor with the project Architect and/or structural engineer.

G. Upon installation of equipment, FEC to secure and silicone equipment base to channel frame.

5.27 PASS-THRU TRIM

A. Where pass-thru refrigerators, freezers, and/or hot food cabinets are installed through the wall, FEC shall trim both sides of the opening, full perimeter, with trim matching the finish of the units installed.

B. Trim to have a continuous appearance, secured with concealed type fasteners.

C. When units are furnished with 6” high stainless-steel legs, FEC shall provide a removable kick plate (toe base) to match the finish of units, unless otherwise specified.

D. The trim shall be fully sealed to the wall.

1. Exposed fasteners are not acceptable.

5.28 BOOSTER HEATERS

A. Booster heaters to be furnished complete with water pressure/temperature relief valve, water pressure regulating valve, low water protection, shock absorber, water treatment system, adjustable thermostat set to provide required supply of 185-º hot water at dish machine spray nozzles, and two (2) temperature/pressure indicating thermometers (one located on the incoming water line to the booster and one on the outgoing line to the dish machine).

1. FEC shall verify all the above items have been installed and are in a location to provide ease of access to all controls, valves, stops, etc., without moving the heater and/or other equipment.

5.29 DISPOSERS

A. The disposer is to be furnished complete with line strainers, chrome plated vacuum breaker, and flow control valves (15 GPM of water flow into the base of disposer; 10 GPM water flow into the end of the trough).

1. Provide 14-gauge stainless steel cover plates for trough at cone or sink, and 14-gauge stainless steel control panel mounting bracket.
2. Unit shall be located so that the body and/or legs are positioned a minimum of 2” back from the front edge of the table.

5.30 FIRE PROTECTION SYSTEMS

A. Provide as shown and described on contract documents.

5.31 BEER DISPENSING TOWER/SYSTEM

A. Draft Beer System sized as per Manufacturer’s requirements to include all necessary components, accessories and fittings required for a complete operating system.

5.32 SODA/JUICE SYSTEMS

A. Soda / Ice / Juice Dispensers are to be furnished by Owner’s Vendor or as described in contract documents.

5.33 LIQUOR SYSTEM

A. Liquor System sized as per Manufacturer’s requirements to include all necessary components for a complete system.

5.34 BEVERAGE CONDUIT AND RACEWAY

A. Acceptable Manufacturer: Conduit – Kelly Bevway, HP Products, or equal.

B. Raceway – Evolution: Stainless Products, or equal.

1. All beverage raceways are to be sized to accept multiple beverages runs for soda, beer, and liquor.
2. Raceway to be constructed of #14- and #16-gauge stainless steel with removable cover.

C. Size and routing as per design drawings. FEC is to verify all routing and coordinate with all trades as to the routing of the raceway and/or conduit.

D. All conduits are to be a minimum of 6" O.D. tubing. See drawings for size and material.

E. FEC is to provide shop drawings indicating all starting and ending points with access and pull points indicated on the drawing and a note as to the content of the raceway or conduit shown, unless specified otherwise.

5.35 UTILITY DISTRIBUTION SYSTEM

A. Stainless steel, self-contained Utility Distribution System (UDS) of size and shape as shown on the contract drawings and further provided as hereinafter specified under "Itemized Specifications."

B. The system shall be completely pre-wired and pre-piped to a single connection point for electrical, gas, cold water, hot water, steam supply, and condensate return as required by the Food Service Equipment specified.

C. All plumbing and electrical services shall include a minimum of 25% over capacity for future changes in food equipment.

D. Code Compliance: The UDS shall be U.L. listed under the category "Commercial Appliance Outlet Center" and manufactured in accordance with the:

1. National Electrical Code (NEC)
2. National Electrical Manufacturers Association (NEMA)
3. National Fire Protection Association (NFPA) pamphlet number 96 & 54
4. Uniform Plumbing Code (UPC)
5. American Society of Mechanical Engineers (ASME)
6. National Sanitation Foundation (NSF)
7. Occupational Safety and Health Administration (OSHA) using only U.L. listed
8. Bureau of Mines rated, AGA certified and CGA certified components.

5.36 PRISON PACKAGE

A. All exposed fasteners to be security-type tamper-resistant, such as Torx pinhead, Hex pinhead, or Tri-Wing.

1. Installation and removal shall only be accomplished with special tools.

2. Hex head cap screws and bolts requiring wrenches for installation and removal may be used.
3. Fasteners with nuts welded on the inside of the equipment are acceptable.

B. Locate all operating controls behind a hinged protective, lockable cover, or door to prevent inadvertent operation.

1. Fabricate the cover or door of formed and welded 16-gauge stainless steel, with windowing comprising ¼-inch thick high-impact-resistant polycarbonate.
2. Secure widowing in place by ¼-inch clips or strips of stainless steel welded to the cover body. Attach cover or door with a full-length 16-gauge stainless steel hinge in combination with a 16-gauge stainless steel locking hasp.
3. Secure a prison-provided padlock with a 3/8-inch diameter x 4-inch-long shackle.
4. Key type switches are not acceptable under any circumstances.

C. Enclose all motors with protective covers retained using tamper-resistant fasteners described above. Covers to be removable for service with special tools.

D. Protect all exposed switches, fuses, circuit breakers, and similar controls with a lockable cover or cover retained using tamper-resistant fasteners as described above.

E. Racks, including storage shelving, mobile service carts, cabinets, and when specified, oven racks, both mobile and stationary, are to be continuously welded at all connecting points, forming a 90 º "L" shape.

F. Permanently affix nameplates and all other forms of product identifications.

5.37 MISCELLANEOUS ACCESSORIES

A. Water Filters:

1. Provide water filters for all ice-making, hot and cold beverage equipment, and all steam boilers.
2. All filter units are to be provided with shut-off valves and quick-change filters.
3. FEC to ensure water supply is comprehensively evaluated, and that the water filter specified effectively treats water within the Manufacturer's water standards.

B. Stainless Steel Enclosures:

1. Provide 20-gauge stainless steel trim to fill in wall openings at Pass-Thru Cabinets.
2. Trim will overlap the wall by approximately 2 inches and be within 1/2 inch of cabinets on the side.
3. Provide for a 3-inch opening between the top of the cabinet and wall.

C. Stainless Steel Ceiling Panels:

1. Provide 20-gauge stainless steel ceiling panels around the perimeter of the Exhaust Hood. Panels shall extend a minimum of 18 inches away from Exhaust Hood.
2. Verify actual panel sizes from Architect's reflective ceiling plan.

5.38 OWNER VENDOR SUPPLIED ITEMS

A. FEC to fully coordinate all Owner furnished items, verify utility requirements, and indicate on shop drawings and utility rough ins, as required.

PART 6 - PROCEDURES

6.1 WORKMANSHIP

A. Entire procedure, including materials, workmanship, details, fabrication, and fastening methods shall comply with applicable standards.

B. Workmanship and finishes shall be in accordance with the best practices of the trade. Only skilled workers shall be employed in the fabrication and erection of the work of this section.

C. Work shall be provided complete in every detail and the finished work shall be strong, rigid, nea.t in appearance, and free from defects as may be determined by the Owner / Project Architect and/or Camacho.

6.2 WELDING

A. Joints in stainless steel shall be electrically welded using stainless steel electrodes. All welds shall be free of pits and flaws.

1. Acetylene welding or silver soldering will not be acceptable.

B. Joints in galvanized material shall be electrically welded using electrodes designed to weld galvanized metal.

1. All welds shall be free of pits and flaws.
2. Acetylene welding will not be acceptable.

C. Materials spot welded together shall have welds equally spaced in straight parallel or perpendicular lines.

1. Spot welding procedure or technique is to be in strict accordance with the recommendations of the material and/or welding machine Manufacturer.

6.3 FINISHING

A. Joints in stainless steel that have been welded shall be ground smooth and polished to a No.4 finish. The grain shall be blended into the grain of surrounding surfaces.

B. Joints in galvanized material that have been welded shall be thoroughly cleaned and finished with one coat of zinc-rich paint (70% minimum).

1. Galvanized steel shall be washed with mineral spirits, primed with Pratt and Lambert Effecto Primer or approved substitute, then spray painted with two (2) coats of Pratt and Lambert Effecto Enamel, or approved substitute of color selected by Camacho / Project Architect.

a. Allow eight hours minimum drying time between the coat of paint and primer.

C. Powder-coated items shall have a fifteen-year warranty against chipping, cracking, fading, scratching and/or damage due to temperature.

1. Colors to be selected by Project Architect.
2. Finish and materials to be approved for food service use by all governing agencies.

6.4 LUBRICATION – OIL AND GREASE

A. Each moving part in the entire food facilities installation shall be provided with suitable bearings with provision for greasing, or with grea.se gun connections suited to a high-pressure gun for distributing Heavy oil or light grease.

1. Points of lubrication shall be readily accessible.

PART 7 - MATERIALS

7.1 HARDWARE

A. Hardware used in the construction of custom-built equipment shall be standard products of an approved hardware Manufacturer and/or as approved by Camacho / Project Architect.

B. Hardware shall be Heavy-duty chrome plated brass (walk-in door hardware shall be Kason or approved equal) or stainless steel where specified, by Component Hardware, Keil, Grant, or Knape.

C. All locks specified on equipment shall be of the same Manufacturer, keyed alike unless otherwise requested by the Owner.

7.2 STAINLESS STEEL COMPONENTS

A. Flat sheets shall be type 304 with no.3 finish, in accordance with ASTM-A-167-70 standard. Materials shall be new, of prime quality, and of full gauge thickness.

B. Stainless steel shall be type 304, 18-8 series, with a content of from 17% to 19% chrome, 7% to 10% nickel and a maximum carbon content of 0.09.

C. The exposed surface shall be interpreted to include all inside surfaces exposed to view when the item is open.

D. Structural shapes shall be type 304 with no.3 finish on all exposed surfaces.

E. Hardware and fittings shall be the standard product of the Manufacturer named as a standard.

F. Tubes shall be type 304, ornamental grade, with no. 4 finish, 16 gauge minimum, seamless drawn.

7.3 GALVANIZED STEEL COMPONENTS

A. Flat sheets shall be type 1, class D, in accordance with FF-QQ-S-775D standard.

B. Structural shapes shall be galvanized by the hot dip process in accordance with ASTM-A-123-69 standards.

1. Tubes shall be welded steel, structural grade, with a hot dipped galvanized finish applied after fabrication.
2. Pipes shall be type S, grade B, schedule 40, in accordance with ASTM-A-53-69 standard.

7.4 BRASS COMPONENTS

A. Flat sheets shall be 70% copper and 30% zinc alloy in accordance with ASTM B19, B36, alloy 260 half-hard finish.

1. Brass tops are to be B & S gauge as specified.
2. Structural sheets are to be B & S 18 gauge and seamless.
3. Brass flat surfaces and structural shapes are to have a mirror finish.
4. Welds are to be restored to a mirror finish and shall blend into the surface of the surrounding surfaces.

7.5 COPPER COMPONENTS

A. Flat sheets shall be hard copper ASTM B152, type ETP. 48 ounces per square foot.

7.6 STRUCTURAL STEEL SHAPES

A. Angles, channels, rods, and bars used as framing members shall be extruded shapes that are uniform in cross-section, ductile in quality, and free from hard spots, runs, checks, or other defects.

B. Structural shapes shall conform to ASTM-A-36-70 standards.

C. Bent or formed sheet metal will not be accepted as a substitute for structural materials unless prior approval in writing is obtained from Camacho / Project Architect.

D. Where brakes are specified, they shall be adjustable, cam acting, side lever with positive brake shoe on the wheel tread.

7.7 INSULATION

A. Fiberglass batts shall be Johns-Manville, Owens-Corning, or W.R. Grace Zonolite blanket insulation.

B. Plastic foam board insulation shall be Dupont urethane or an approved substitute.

C. Insulation thickness indicated shall be foamed in place or constructed from multiple layers of board insulation of batts with staggered joints and perpendicular seams.

7.8 WOOD

A. Lumber shall be free from knots, pitchy sea.ms, or other imperfections, thoroughly air-seasoned and Kiln dried.

1. Cover all unexposed surfaces with two coats of odorless waterproof coating.

B. Plywood shall be a marine grade or exterior APA grade with closed grain and of thickness specified.

C. Exposed wood surfaces to be Birch, interiors to be Cypress, Spruce, or Northern White Pine.

1. Frame casings and jambs to be clear Douglas fir.

7.9 FIBERGLASS (FRP)

A. Fiberglass Reinforced Polyester (FRP) shall be molded with permanent color, minimum thickness, 1/8", glass content 33% minimum, Barcol hardness at least 55, a flexural strength of 30,000 PSI minimum, tensile strength 25,000 PSI.

1. All FRP parts shall be by Manufacturer and color as selected by the Project Architect and/or Owner.

B. Where finished FRP parts are used in conjunction with casters or other metallic parts which impart concentrated stress at specific points, these points shall be reinforced with stainless steel battens, bars, or other required shapes.

C. Fire ratings shall be as specified by the Project Architect.

7.10 PLASTIC LAMINATING

A. Plastic laminated panels shall be constructed of 3/4" thick marine grade plywood veneered on all exposed surfaces with a plastic laminate of pattern and color as selected by Architect / Interior Designer,

B. Seal all unexposed sides with 1/8" Masonite.

C. Plastic and Masonite shall be pressure laminated to plywood with mastic recommended by the plastic Manufacturer.

D. No joints shall be permitted when standard sheet size will permit panels to be constructed without joints.

E. Grain on upright surfaces shall run vertically. All inside corners are to be sealed with an approved Sealer as per above.

7.11 CASTERS

A. Casters on prefabricated equipment shall be the equipment Manufacturer's standard product as specified under the itemized equipment list.

B. Casters on custom-built equipment shall be Jarvis N.S.F. non-marking polyurethane or approved substitute or as specified under itemized specifications.

1. Casters shall have wheel sizes indicated.
2. Standard duty (S.D.) casters shall be No. 5-25-111
3. Swivel plate casters or No. 5-30-113.
4. Heavy duty (H.D.) casters shall be No. 5-30-113 plate casters.

C. Secure plate casters with four (4) 1/4-20 stainless steel bolts, stainless steel lock washers, and stainless-steel nuts.

7.12 FAUCETS, SPRAY UNITS, AND ACCESSORIES

A. All faucets, spray units, and accessories shall be chrome-plated, heavy-duty brass, equipped with removable seats and aerators, manufactured by T&S Brass.

1. Fisher is an approved Manufacturer.

B. Each faucet shall be furnished with 4” wrist action handles unless otherwise noted in the itemized specifications.

C. One (1) faucet shall be provided for each sink bowl unless otherwise shown on drawings and noted in the itemized specifications.

D. T&S Faucets to be used are listed below.

1. Backsplash mounted faucet No. B-0231-CR with 12” swing faucet and 1/2” inlet.
2. Backsplash mounted faucet No. B-0290 with 12” swing spout and 3/4” inlet.
3. Backsplash mounted pre-rinse/faucet assembly No. B-0133-12A-CBJST with 12” swing spout and 1/2” inlet (vegetable prep and pot wash sinks).
4. Backsplash mounted pre-rinse assembly No. B-0133-CR with 1/2” inlet (ware wash sink).
5. Backsplash mounted pre-rinse/faucet assembly No. B0287-CBJST with 12” swing spout and 3/4" inlet.
6. Top or deck-mounted faucet No. B-0300-CR with 12” swing spout and 1/2” inlet.
7. Top or deck-mounted faucet No. B-0325-CR with 1/2” inlet (hand sinks only).

8. Top or deck-mounted faucet No. B-1142-04-CR with 1/2” inlet (Servery sinks only).
9. Top or deck-mounted electronic faucet No. EC-3100-HG with 1/2” inlet (Servery sinks only).
10. Service sink faucet No. B-0665-BSTP-CR

E. All units are to be complete with check valves as listed below.

1. Vertical No. B-CW1-2 with 1/2” inlet.
2. Horizontal No. B-CVH1-2 with 1/2” inlet.
3. Vertical No. B-CW3-4 with 3/4” inlet.
4. Horizontal No. B-CVH3-4 with 3/4” inlet.

F. Pot fill faucet assembly (wall mounted) No. B-2312 as manufactured by T&S Brass.

G. Fill faucet assembly (serving counter) No. B-101-A modified with No. 013E-84 flexible stainless-steel hose, No. B-KF built-in flange and No. B-0512 mixing valve complete with check valves.

H. Cart washer spray unit (wall mounted) No. MV-0771-12R complete with check valves.

I. Hose Reel assembly, closed, No. B-7142-U01-WS8B-C with 50’-0” hose (unless otherwise specified), stainless steel surface mount control box.

J. Hose Reel assembly, open, No. B-7142-02 with 50’-0” hose (unless otherwise specified.

K. Small undermount hose reel assembly No. B-7161-C with No. B-0512 mixing valve.

L. Vacuum breakers shall be mounted neatly above the tabletop or backsplash as required.

1. Provide No B-0455-04 (for a flat surface) and B-0455-M3991 (for a 45-º surface) with 1/2”.

7.13 SINK DRAINS

A. Sink drains shall be a minimum of 2” IPS, or as specified, complete with a rear-connected overflow for Each sink bowl and 4” long chrome plated tailpiece.

1. Interconnect multiple same-size drains with chrome-plated continuous waste assembly, where two (2) or more drains are mounted immediately adjacent to each other.

B. All sinks drain units shall be quick opening type No. B-3950-01 stainless steel rotary drains with stainless steel twist handle assembly (unless otherwise specified) and overflow assembly.

1. Furnish overflow assembly in accordance with sink depth as required.

C. Where specified furnish Component Hardware No. D34-Y011 stainless steel box pattern waste with stainless steel basket and cover for floor troughs.

D. Sink Bowls containing 180º-190º hot water shall be provided with an 8”x10” red plastic warning sign on the wall above the sink compartment.

1. The sign shall have white incised letters and shall read as follows:

a. “WARNING: THIS SINK BOWL (AND OR FAUCET) CONTAINS VERY HOT 190° WATER – USE EXTREME CARE.”

7.14 QUICK DISCONNECT ASSEMBLIES

A. Each of the following gas hose kits shall consist of a stainless-steel braided hose with extruded coating, quick disconnect fitting, two (2) full-flow swivel link connectors, one (1) 90-º street elbow (when required), one (1) AGA certified gas ball valve, one (1) Sure link restraining cable and all necessary hardware as manufactured by T&S Brass or Dormont.

1. No. HG-4C-*SK with 1/2” gas inlet.
2. No. HG-4D-*SK with 3/4” gas inlet.
3. No. HG-4E-*SK with 1” gas inlet.
4. No. HG-4F-*SK with 1-1/4” gas inlet.

B. Each of the following water hose kits shall consist of a stainless-steel braided hose with extruded coating, quick disconnect fitting, two (2) full-flow swivel link connectors, one (1) 90-º street elbow (when required), one (1) Sure link restraining cable and all necessary hardware as manufactured by T&S Brass or Dormont.

1. No. HW-4B-*SK with 3/8” water inlet.
2. No. HW-4C-*SK with 1/2” water inlet.
3. No. HW-4D-*SK with 3/4" water inlet.

C. Each of the following flexible coiled water hose kits are for use with coffee and tea. makers and similar applications requiring smaller diameter hoses for cold water connections only not to exceed 70 degrees, as manufactured by T&S Brass or Dormont.

1. No. CW-2A-60 or CW-4A-60 with No. AW-5A-SS stainless steel quick disconnect; 1/4” inlet.
2. No. CW-2B-60 or CW-4B-60 with No. AW-5B-SS stainless steel quick disconnect; 3/8” outlet.

D. FEC is to field verify the hose length required for each application to ensure the hose does not rest on the floor and equipment can be moved for cleaning.

PART 8 - INSTALLATION

8.1 UTILITIES, DELIVERY, STORAGE, AND SPECIAL HANDLING

A. GC/CM shall provide and pay for the temporary power and light, openings, and storage space to permit the scheduled delivery of equipment.

1. See Section 01 50 00 for further clarification.

B. The FEC shall verify door openings, passages, and conditions at the building.

C. The FEC. shall pay for all equipment, special handling charges.

D. Foodservice equipment to be delivered in factory-fabricated containers designed to protect equipment and finish until final installation.

E. The FEC shall make arrangements to receive equipment at the project site, or to hold equipment in a secure warehouse until delivery can be made to the job site.

1. Coordinate all site deliveries with GC/CM.

F. Store food service equipment in original containers, and in a location to provide adequate protection to equipment while not interfering with other construction operations.

G. Manage food service equipment carefully to avoid damage to component enclosures and finish.

H. Do not install damaged food service equipment.

1. Return damaged components to the equipment Manufacturer and replace them as required.

I. Make arrangements to receive equipment and make delivery into the building.

1. Do not consign any equipment to the Owners or any other Contractor unless written acceptance from them and satisfactory arrangements have been made for the payment of freight and all handling charges.

8.2 CONDITIONS AND PREPARATION

A. Verify all pertinent field dimensions of the building and examine conditions affecting the proper execution of this section, giving consideration to any Architectural, Mechanical, or Structural discrepancies which may occur during the construction of the building.

1. No extra compensation shall be allowed for any difference between the actual dimensions secured at the job site and the measurements indicated on the Contract Drawings.
2. Any differences that may be found during field measurements shall be submitted to the Architect for consideration before proceeding with the fabrication or supplying of any equipment.

B. Evaluate access to various areas for moving in of equipment and coordinate with GC/CM.

1. Verify water pressure requirements and coordinate the required reducing valve with Plumbing Contractor.
2. Inspect flooring, depressions, raised concrete bases, and wall finishes.
3. Verify the existence of required mechanical and electrical rough-ins.
4. Check painting, ceiling installation, and all kitchen equipment.

C. Coordinate with the Project Superintendent for the proper sequence for installation of equipment and wall finish.

D. Sweep and clean all floor areas and tops of raised concrete bases before setting equipment in place; remove any spillage or foreign matter.

E. Dispose of all packaging and debris per Construction Waste Management Plan.

8.3 PLACEMENT

A. Place all fitting and fastening necessary to install fixed items or sub-items in a permanent position as shown on plans.

B. Place all portable items or sub-items which do not require plumbing or electrical services as shown on plans or as directed by Camacho / Project Architect.

8.4 ERECTION

A. Work shall be erected plumb, square, and unwrapped by experienced personnel.

B. Protect all metal surfaces in contact with masonry, concrete and/or dissimilar metals with an acceptable non-absorbent tape and/or gasket material.

C. Work shall be erected in correct horizontal and vertical alignment at the locations shown on the drawings.

D. Frames shall be anchored in place with sufficient anchorage to withstand live load with no apparent movement or tendency to fail.

E. Installation screws and fasteners shall be installed carefully to avoid scratching and/or damaging adjacent surfaces and/or fastener hea.ds and shall be stainless steel.

F. At the completion of erection work, finished surfaces shall be free of hammer and tool marks, scratches, blemishes, rust, and stains.

1. Equipment shall be suitably protected by FEC during installation to prevent damage by other trades.

G. Provide general &/or seismic restraining devices in areas requiring such, as per local codes.

8.5 CLEARANCE

A. Edges of splashes on open base fixtures that are adjacent to walls shall have a 3" cleaning clearance or be sealed,

1. Seal bead not to exceed 3/8", when against a wall.

B. Edges of splashes on closed base fixtures that are adjacent to a wall or other solid fixtures higher than the splash shall form tight hairline joints.

C. Seal joints with clear FDA-approved clear silicone Sealant.

1. All excess Sealant is to be cleaned out to a smooth radius fillet.

8.6 FIELD JOINTS

A. Field joints in stainless steel and/or brass tops shall be welded, ground, polished and finished as specified herein.

B. Body joints shall be drawn type with hairline joints.

C. Provide angle bracing on each side of the body joint, 3/8" stainless steel diameter draw bolts, a lock washer and lock nuts.

8.7 UTILITY SERVICE CONNECTIONS

A. Plumbing, Electrical, and Mechanical furnished by the FEC shall be limited to that which is built-in or is an integral part of the equipment itself.

B. Final utility installation and connections shall be by related trades and is to be included in the G.C. / C.M. contracts.

C. Provide restraining devices with mobile cooking equipment as required.

8.8 CONTRACTOR COOPERATION

A. Cooperate with and render all necessary assistance to other Contractors concerned with roughing-in and final connection of utility services for this contract.

B. After final utility connections are made, thoroughly Clean, sanitize, polish, and inspect the proper function of all items.

C. Report malfunctioning, incomplete, or missing items, Owner furnished equipment or components to Camacho / Project Architect.

8.9 COORDINATION

A. It shall be the responsibility of FEC to keep up to date with progress made in the field and installation of all necessary utility rough-ins required to accommodate all equipment specified, as shown on drawings, and to make as many visits to the job site as is necessary to check and assure all rough-ins are being properly installed to accommodate this equipment.

B. FEC to cooperate with all trades so that the end results of this work will be a professional, complete, approved, and accepted installation.

C. Written reports of Each visit shall be sent promptly to the Project Architect and Camacho.

D. Progress of construction is of paramount importance in the execution of this project.

E. FEC is to conduct its work so that no delay in the completion of this project is incurred.

F. FEC is to procure all specified equipment and coordinate installation as required by the project schedule.

8.10 EXISTING TO BE RELOCATED EQUIPMENT

A. All equipment noted in the specification as “Existing to Be Relocated” shall be modified (if required) and relocated as specified and shown on contract drawings.

B. Any data provided for Each “Existing to Be Relocated” item is the best available at the time the drawings were prepared and is provided for planning purposes only.

C. It is the responsibility of the FEC to field verify all data required for roughing-in of existing equipment.

D. The FEC shall carefully examine the specifications and project site including the location and condition of existing equipment to determine the cost for each “Existing to Be Relocated” item to cover marking, removal, modification (if required including materials), transportation to and from the site, storing, cleaning, inspection for damage, repair, and resetting.

E. The FEC to coordinate locations of existing equipment with the Owner.

F. All disconnecting and reconnection of services to existing relocated equipment shall be performed by related trades.

G. The FEC to document the operating condition of equipment noted as “Existing to Be Relocated” before being disconnected and removed to note any damage, scratches, and broken components prior to placing it in storage.

H. The FEC shall protect equipment during transport and storage and assume responsibility for its resetting in the condition viewed prior to removal.

I. The FEC is not responsible for repairing or refurbishing equipment noted as “Existing to Be Relocated” unless specifically called for in the written specifications.

J. The FEC is not required to provide a warranty or guarantee on existing equipment. If existing equipment requires new components which are to be provided by the FEC, such components shall be warranted and/or guaranteed.

8.11 RESERVATIONS AND CONDITIONS

A. It is the intent of this specification to complete the installation of all equipment covered herein in all phases ready for operation.

B. The FEC shall carefully examine the plans and the specifications for building construction contracts and determine therefrom the extent of its operations in all respects.

C. All labor and materials not included in building construction contracts necessary to accomplish the intent are hereby included in this contract.

D. The FEC shall make all arrangements for receiving equipment and make delivery into the building.

1. The FEC shall not consign any equipment to the Owner or any other Contractor unless written acceptance from them and satisfactory arrangements have been made for the payment of freight and all handling charges.

E. The FEC shall attend the first job meeting and subsequent job meetings, as required, for the purpose of coordinating his work with other trades.

F. All equipment shall be delivered into the building fully protected, uncrated, assembled, leveled, and fully protected.

1. It will be the responsibility of the FEC to protect the equipment until completely installed and accepted.

G. The FEC to set equipment temporarily in its final locations, permitting the mechanical and electrical trades to take the necessary measures for the connection of the service lines; then move the equipment sufficiently to allow the installation of such service lines.

1. After which realign the equipment level and plumb, making the final erection as shown in the Contract Drawings.
2. All equipment shall be installed to eliminate objectionable vibration.

H. The FEC shall do all things and furnish all material necessary to conduct the full intent and meaning of these specifications.

I. The FEC is to be initiative-taking in their involvement with the project and shall have a competent Food Service Equipment Foreman on the premises to assist in furnishing information and supervising the installation of Food Service Equipment under this Section.

1. This Foreman shall verify the correct locations for rough-Ins, shall monitor work in progress, and coordinate their work as required to meet all scheduled dates.

8.12 ACCEPTANCE

A. Camacho will inspect the completed work connected with this section for compliance with the Contract Documents, upon notification by the Owner, Project Architect, or the FEC, whichever occurs first.

B. Prior to acceptance of the work of this Section, FEC shall clean, sanitize, polish, and treat all stainless steel, cast iron, enamel porcelain, and other type surfaces in accordance with the Manufacturer's recommendations and/or procedures.

C. Prior to acceptance of this Section, the FEC shall clean and retouch all painted surfaces,

D. Powder-coated surfaces that have been damaged must be re-finished by an established powder-coating firm.

E. NOTE: In addition to the stipulated retainage of payment as required, the Owner shall retain an additional (10%) ten percent of the line item applicable to "Food Service Equipment" as listed in the Contractor's Schedule of Values.

1. This additional retainage will be released only after the requirements of this section of these specifications are met and approved in their entirety to the complete satisfaction of the Consultant and Owner's Project Manager.

8.13 TESTING, DEMONSTRATING, AND INSTRUCTING

A. The FEC shall at the completion of this work remove all debris, crating, packaging materials, and implements associated with this work leaving the area. broom clean.

B. The FEC shall provide and maintain protective covering for finished surfaces and other parts of equipment and/or cooler/freezer assemblies subject to damage during and after installation.

C. Clean, test, adjust, and calibrate by factory-authorized service agency all food service equipment and fixtures to make them ready for operation when the facility is turned over to the Owner.

D. After the above is complete, FEC shall devote one (1) full working day to monitoring all items furnished under this Contract are operational and thoroughly evaluated to ensure proper safe operation.

1. The Owner, the Food Service Consultant, the G.C. and/or C.M. shall be notified of this testing and is to be provided with a copy of the service agencies' report.

E. When the Food Service Equipment has been cleaned and tested and is operating properly, the FEC shall arrange and coordinate to have equipment furnished under this section of the contract demonstrated, pursuant to the availability of the Owner and its Representatives, by Authorized Representatives who are to instruct the Owner's designated personnel in the use, care, and maintenance of the equipment.

1. NOTE: Attendance at the demonstration meeting is required of all Manufacturers' designated representatives providing equipment under this Contract and is to occur at one meeting.

F. Coordinate start-up of equipment with testing and balancing of the HVAC system.

1. Ensure that the HVAC will be operating correctly, even during maximum equipment use.

G. The FEC shall be responsible for scheduling the demonstration meeting.

1. Each Manufacturer's representative shall be present at this meeting:
2. Demonstrate to and instruct the Owner's designated personnel as to the operation, use, care, cleaning, and maintenance of all items of equipment supplied and respond to all questions and concerns by written response.
3. Supply the Architect with an affidavit signed by the Owners or Food Service Manager/Director that this service was rendered and performed.

H. Provide the Owner's Designated Representative with the name, address, and telephone number of a designee of Each Manufacturer and state which designee shall be responsible for quickly responding to warranty work 24 hours a day, 365 days a year.

1. This is to be a Direct Contact.

I. The Owner may contact such Warranty Representative’s Designee directly, and such Designee may respond without voiding any responsibility or warranties of the Manufacturer, the FEC, the G.C. and/or the C.M. Service charges for this warranty representative.

J. No matter what the resolution of the problem may be, shall be the responsibility of the Manufacturer, the FEC, the G.C and/or the C.M.

1. In any event, the FEC shall be responsible to immediately pay upon invoice, charges by the warranty representative in order to keep. the Warranty Representative responsive.

    a. Whether the Plumbing, Electrical, Food Service Equipment, or other Sub-Contractors (or even the Owner) should be back charged will be resolved later.

K. Provide the Owner's Representative with two (2) booklets for each item of equipment furnished under this contract.

1. This set shall be neatly bound in a three-ring binder, by FEC with the delivery of this booklet receipted at the time of delivery.

2. The booklets shall contain:

    a. Operation Maintenance Manuals.
    b. Instructions.
    c. Warranties.
    d. Part lists of all bought-out items provided under this section.
    e. List of names, addresses, telephone numbers, and emails of local authorized service agencies.

3. Where available, provided videos to show and detail the proper care and maintenance of equipment.

L. Attendance at the one demonstration meeting is required of all Manufacturers' Representatives providing equipment under this contract.

1. If for any reason an additional meeting must be scheduled, the FEC will be responsible for all additional fees and costs incurred.

M. After all connections to equipment have been completed, conduct the final test or tests of equipment in the presence of the Architect or Authorized Representative for a period of one. (1) hour minimum.

1. Adjust and lubricate as required.

N. Each piece of equipment with a heating device shall be evaluated for temperature control and/or thermostat functions.

1. Thermostats shall be re-calibrated as needed.

O. Provide a training program by a Serve Safe Certified Culinary Chef to consist of one (1) day within ten days of a start-up, showing all equipment and how it works with demonstrations.

1. The Trainer shall monitor Employees and demonstrate how to safely use equipment with live cooking.
2. The service provided shall include abbreviated classes in Serve Safe and HACCP and the proper method for receiving and storing product.
3. Training consists of a total of four (4) hours.

P. The Contractor shall issue a letter, signed by all sub-contractors involved, and co-signed by the Owner's representative, stating the Owner or the Food Service Manager/Director and/or staff have been satisfactorily instructed in the use, operation, and minor maintenance of the equipment.

PART 9 - CORRECTION OF DEFECTS, SERVICES, GUARANTEES, AND RESPONSIBILITIES

9.1 GENERAL

A. All equipment shall be delivered in an undamaged condition upon completion.

B. FEC shall replace, at the Owner's, Camacho's and/or the Project Architect's discretion, or make satisfactory repairs to any item of equipment that fails to conform to the requirements of the contract at the time and shall remedy any defects due to faulty materials or workmanship which appear within a period of one (1) year from start-up and demonstration of equipment.

C. Items shall be evaluated and adjusted by skilled mechanics and this Contractor shall guarantee the material and workmanship of the equipment furnished by him under these specifications, for a period of one (1) year after acceptance by the Owner.

D. All equipment, refrigeration systems, and ice makers shall have start-up and a two (2) year extended service warranty for parts and labor and a five (5) year extended warranty on compressors which will start on the date of Owner's acceptance.

1. All additional warranties as noted in the itemized specification shall be factory-purchased warranties for each item; proof of warranties shall be provided to the Owner, Architect, and FEC for record.
2. The cost of all warranties shall be included in the bid proposal and contract sum and shall serve as a prepaid service contract.

E. Contractors who do not normally maintain local Refrigeration Service Personnel shall be required to provide the Owner with a refrigeration service policy in writing from a local Refrigeration Service Company that maintains a twenty-four (24) hour call service and that is acceptable to the Owner for a period of one (1) year at no additional expense to the Owner.

F. Service contracts on refrigeration systems must be contracted by the FEC with authorized local service organizations capable of providing prompt and efficient service.

1. Submit six (6) copies of all service contracts, as specified herein, upon completion of the installation of the equipment to the Owner.

G. Provide the Owner a listing of Factory-Authorized Service Agencies and copies of written service and warranty agreements on all items of equipment provided under this contract, excluding Owner furnished and/or Existing items.

PART 10 - EXAMINATION OF PLANS AND SPECIFICATIONS

10.1 Plans and specifications are furnished for the use of the FEC in preparing an itemized cost estimate and indicating the design intent of Camacho.

A. It is the responsibility of the FEC to examine all documents, which include the contract drawings and specifications, to ensure there are no typographical errors, discrepancies in quantities, drafting errors, utility information, Manufacturer and model numbers, options, etc. which would affect the outcome of a complete and professional bid.

1. Should a model number no longer be available and/or has been replaced, the latest model shall be provided.
2. All discrepancies and verification requests shall be brought to the attention of Camacho / Project Architect (PA) prior to the submittal of the bid and are to be addressed in the form of a written RFI to Camacho with a copy to the PA for interpretation.
3. In the case these discrepancies and verifications are not brought to the attention of Camacho / Project Architect prior to the submittal of the bid, the FEC will be fully responsible to furnish and provide the equipment as represented by Camacho, within reason, at no additional cost to the Owner.

PART 11 - MISCELLANEOUS REQUIREMENTS

11.1 UNIFORM QUALITY

A. Custom-built items must be constructed by the same fabricator to ensure uniform quality and appearance.

B. Similar type items of manufacture and/or prefabricated equipment must be the product of the same Manufacturer.

11.2 IDENTIFICATION PLATES

A. Each piece of equipment must have a suitable nameplate supplied by the Manufacturer that is to include the name of the Manufacturer and the electrical and/or utility demands.

B. Each switch and/or control device shall have an approved nameplate indicating its function or purpose such as display shelf lights, frost plate compressor, and plate warmer.

C. Indicator dials and other standard components of prefabricated equipment will be considered acceptable identification of their physical location clearly indicating the warmers and/or other equipment items that they control.

D. All nameplates must be non-corrosive metal with engraved letters or have acid etched, phenolic and/or painted letters.

PART 12 - ITEMIZED SPECIFICATIONS

ITEM 01 - COMBI-VECTOR PRE-STACKED CONFIGURATION, (6-10 OR 7-20) COMBI OVEN STACKED ON (VMC-F3E OR VMC-F3G)) MULTI-COOK OVEN, ELECTRIC
Alto-Shaam Model CV3

A. It is the sole responsibility of the owner/operator/purchaser of this equipment to verify that the incoming water supply is comprehensively tested and, if required, provide a means of water treatment that would meet the compliance requirements with the manufacturers water quality standards published on the product spec sheet. Non-compliance with these minimum standards will potentially damage this equipment and/or components and VOID the original equipment manufacturers warranty
B. Model 7-20E CLASSIC Prodigi™ Classic Combi Oven/Steamer, electric, boiler-free, countertop, (7) 18" x 26" full size sheet or (16) 12" x 20" full size hotel pan (GN 1/1) capacity, programmable, touch-screen control with steam/convection/combi cooking modes, SafeVent™ steam venting, (5) cleaning levels, door hinged right, high efficiency LED lighting, (2) side racks with (8) non-tilt support rails, stainless steel construction, adjustable stainless steel legs, EcoSmart®, cULus, UL EPH Classified, CE, IPX5, EAC, city-wide COA for New York City
C. ECO
D. Model 5031719 Stacking Hardware, Combi 7-20 over Vector F Electric Series
E. Model VMC-F3E Vector® F Series Multi-Cook Oven, electric, (3) individually controlled cooking chambers, holds (6) half-size sheet pans (3) full sized sheet pans, programmable touch screen controls with Structured Air Technology®, double pane glass door, interior LED cavity lighting, includes: (1) wire rack & (2) jet plates per cooking chamber, USB port, stainless steel construction, 4" adjustable legs, cULus, UL EPH Classified, Made in USA

ITEM 02 - RANGE, 36", 2 OPEN BURNERS, 24" CHARBROILER
Vulcan Model 36C-2B24CBN Dimensions: 58(h) x 36(w) x 34(d)
Endurance™ Restaurant Range, natural gas, 36", (2) 30,000 BTU open burners, (1) 24" charbroiler, lift-off burner heads, convection oven, stainless steel front, sides & backriser, fully MIG welded chassis, 6" adjustable legs, 159,000 BTU, CSA, NSF

A. Model CASTERS-RR4 Casters, 5" (set of 4) (2 with locks)
B. T&S Brass Model HG-4D-48SK-PS Safe-T-Link Gas Connector Kit, 3/4" connection, 48" hose, stainless steel braiding with extruded coating, (1) Quick-Disconnect, (2) Swivelink fittings, (1) 90° elbow, ball valve, restraining cable adjustable for 3' to 5' & Posi-Set, 180,000 BTU / hr minimum flow capacity

ITEM 03 - GRIDDLE, GAS, COUNTERTOP
Southbend (Middleby) Model HDG-36 Dimensions: 16.13(h) x 36(w) x 33.75(d)
(QUICK SHIP) Griddle, countertop, gas, 36" W x 24" D cooking surface, 1" thick polished steel plate, thermostatic controls, battery spark ignition, flame failure safety device, stainless steel front, sides & 4" adjustable legs, 90,000 BTU, CSA, NSF (Ships within 2 days, maximum quantity = 2 per order)

A. T&S Brass Model HG-4D-48SK-PS Safe-T-Link Gas Connector Kit, 3/4" connection, 48" hose, stainless steel braiding with extruded coating, (1) Quick-Disconnect, (2) Swivelink

fittings, (1) 90° elbow, ball valve, restraining cable adjustable for 3' to 5' & Posi-Set, 180,000 BTU / hr minium flow capacity

ITEM 04 - EQUIPMENT STAND, REFRIGERATED BASE
Hoshizaki Model CR36A Dimensions: 27(h) x 36.5(w) x 33.25(d)
Steelheart Series Refrigerated Equipment Stand, one-section, 36-1/2"W x 33-1/4"D x 27"H, (2) drawers: each will accommodate (1) 12" x 20" x 6" deep pans & (1) 1/2 size long 6" deep pan (pans not included), solid state digital controller with temperature alarms, LED display, stainless steel exterior front, sides, & top, stainless steel interior, side-mounted self-contained refrigeration, R290 Hydrocarbon refrigerant, 1/5 HP, 115v/60/1-ph, 2.2 amps, cord with NEMA 5-15P, (4) 4" casters, cETLus, ETL-Sanitation

ITEM 05 - GAS FLOOR FRYER
Vulcan Model 1TR45AF Dimensions: 47.25(h) x 15.5(w) x 30.13(d)
PowerFry3™ Fryer, gas, high efficiency, 15-1/2" W, free-standing, 45-50 lbs. capacity, solid state analog knob control with melt cycles, ThreePass™ heat transfer system, electronic ignition, KleenScreen PLUS® filtration system, twin baskets, stainless steel cabinet & fry tank, adjustable casters (2 swivel locking & 2 non-locking), 70,000 BTU, CSA, CSA STAR, NSF, ENERGY STAR®

A. Model BASKETS-TWINRD Set of Twin Baskets, for all 35, 45 & 50 lbs. fryers
B. T&S Brass Model HG-4D-48SK-PS Safe-T-Link Gas Connector Kit, 3/4" connection, 48" hose, stainless steel braiding with extruded coating, (1) Quick-Disconnect, (2) Swivelink fittings, (1) 90° elbow, ball valve, restraining cable adjustable for 3' to 5' & Posi-Set, 180,000 BTU / hr minium flow capacity

ITEM 06 - SPARE NO.

ITEM 07 - 1 COMPARTMENT SINK PREP TABLE
Fabricated Model 1CSPT
Prep table with 1-Compartment Sink, 8'-0" long X 2'-6" wide X 36" high, all 14 gauge type 304 stainless steel construction. Table to be fully welded construction with all welds ground and polished to a uniform finish. Top to be provided with 8" high back splash, 2" return on 45 degree angle and 1" turned down, attach to wall with stainless steel Z-clips, marine edges, stainless steel cross bracing, stainless steel legs and stainless steel adjustable flanged feet. All exposed back and end splashes to be enclosed, fully welded, ground and polished.

Sink to be 22" long X 20"wide X 12" deep, provided with T&S Brass #B-3950-01 Waste Valve, twist handle and overflow assembly for 3-1/2" sink opening, 2" drain outlet with 1-1/2" adapter and stainless steel lever waste bracket. Crease bottom of sink bowl to pitch to the drain. Sink to be provided with 1" deep recessed perimeter to support removable cutting board. Provide stainless steel skirt to cover sink bowl.

Unit to be further constructed in accordance with shop drawings.

APPROVED SHOP DRAWINGS REQUIRED PRIOR TO CONSTRUCTION.

A. T&S Brass Model B-0231-CR-KIT Pantry Faucet, double, wall mount, 8" centers, 12" swing nozzle, lever handles, stream regulator tip, ceramic cartridge, low lead, (2) 24" flex hose, 1/2" NPT, NSF, ADA compliant

ITEM 08 - MOBILE WORK TABLE
Fabricated Model MWT
Mobile work table, all stainless steel construction,5'-0" long X 2'-6" wide X 36" high. Table to be fully welded construction with all welds ground and polished to a uniform finish. Top to be 14 gauge type 304 stainless steel with 1-3/4" rolled edge. Stainless steel cross bracing, stainless steel legs and (4) 5" diameter non-marking polyurethane swivel casters, (2) with brakes.

Unit to be further constructed in accordance with shop drawings.

APPROVED SHOP DRAWINGS REQUIRED PRIOR TO CONSTRUCTION.

ITEM 09 - WORK TABLE
Fabricated Model WT
Work table, all stainless steel construction, 8'-0" long X 2'-6" wide X 36" high. Table to be fully welded construction with all welds fully ground and polished to a uniform finish. Top to be 14 gauge type 304 stainless steel with 1-3/4" rolled edges, 8" back splash with 2" return on 45 degree angle and 1" turned down, attach with stainless steel Z clips, stainless steel cross bracing, stainless steel legs and stainless steel adjustable bullet feet (stainless steel flange feet when sink is specified). All exposed back and end splashes to be enclosed, fully welded, ground and polished.

Unit to be further constructed in accordance with shop drawings

APPROVED SHOP DRAWINGS REQUIRED PRIOR TO CONSTRUCTION.

ITEM 10 - SPARE NO.

ITEM 11 - SPARE NO.

ITEM 12 - HAND SINK
Eagle Group Model HSA-10-FA-1P Dimensions: 39.25(h) x 18.88(w) x 14.75(d)
Hand Sink, pedestal mounted base, 13-1/2" wide x 9-3/4" front-to-back x 6-3/4" deep bowl, 304 stainless steel construction, splash mount gooseneck, single foot pedal, spout, P-trap & tail piece, basket drain, deep-drawn seamless design-positive drain, inverted "V" edge, NSF

A. Model -LRS Left & right side splashes

ITEM 13 - SOLED DISH TABLE
Fabricated Model SDT
Soiled dish table, all stainless steel construction 9'-0" long X 2'-6 wide X 34" high. Table to be fully welded construction with all welds ground and polished to a uniform finish. Top to be 14 gauge type 304 stainless steel with 8" high back splash, 2" return on 45 degree angle and 1" turned down, attach to wall with stainless steel Z-clips, 3" high X 1-3/4" rolled edges, stainless steel cross bracing, stainless steel legs and stainless steel adjustable flanged feet. All exposed back and end splashes to be enclosed, fully

welded, ground and polished.

Unit to be further constructed in accordance with shop drawings.

APPROVED SHOP DRAWINGS REQUIRED PRIOR TO CONSTRUCTION.

A. T&S Brass Model B-0133-CR-B08SK EasyInstall Pre-Rinse Unit, 8" wall mount, quarter-turn cerama cartridges with check valves, lever handles, EasyInstall 18" riser, 44" flexible stainless steel hose, 1.07 GPM JeTSpray valve with swivel (B-0108), 6" wall bracket, 1/2" NPT male inlets, installation kit (B-0230-K), low lead, NSF
B. T&S Brass Model B-0230-K Installation Kit, (2) 1/2" NPT nipples, lock nuts & washers, (2) short "Ell" 1/2" NPT female x male

ITEM 14 - CLEAN DISH TABLE
Fabricated Model CDT
Clean dish table, all stainless steel construction 7'-0"long X 2'-6" wide X 34" high. Top to be 14 gauge type 304 stainless steel with 8" high back splash, 2" return on 45 degree angle and 1" turned down, attach to wall with stainless steel z-clips, 3" high X 1-3/4" rolled edges, stainless steel cross bracing, stainless steel legs and stainless steel adjustable flanged feet. Provide accommodations for table limit switch. Table to be fully welded construction with all welds ground and polished to a uniform finish. All exposed back and end splashes to be enclosed, fully welded, ground and polished.

Unit to be further constructed in accordance with shop drawings.

APPROVED SHOP DRAWINGS REQUIRED PRIOR TO CONSTRUCTION.

ITEM 15 - SHELVING, WITH METAL FRAME
Metro Model MQ2454G Dimensions: 54(w) x 24(d)
Quick Ship - MetroMax® Q Shelf, 54"W x 24"D, removable open grid polymer shelf mats on an epoxy coated steel frame with quick adjust corner releases, (4) wedge connectors, Microban® antimicrobial product protection, 600 lb. capacity per shelf, NSF

A. Model MX74UP Quick Ship - Polymer trilobal post (compatible with MetroMax® i, MetroMax® 4, MetroMax® Q), 73-3/16"H, for use with stem casters, adjusts at 1" increments, corrosion proof all polymer construction with built in Microban® antimicrobial product protection
B. Model 5PCX Quick Ship - Polymer Stem Caster, swivel, 5" dia., 1-1/4"W face, -20° F to 120°F temperature range, polyurethane wheel tread, 300 lb. capacity, NSF (donut bumpers included) (for use with all MetroMax posts & shelves)
C. Model 5PCBX Quick Ship - Polymer Stem Caster, brake, 5" dia., 1-1/4"W face, -20° F to 120°F temperature range, polyurethane wheel tread, 300 lb. capacity, NSF (donut bumpers included) (for use with all MetroMax posts & shelves)

ITEM 16 - 3-COMPARTMENT SINK SCULLERY TABLE
Fabricated Model 3CSST
Scullery table with 3-Compartment Sink, 10'-0" long X 2'-10" wide X 36" high, all 14 gauge type 304 stainless steel construction, size and shape per plan. Table to be fully welded construction with all welds ground and polished to a uniform finish. Top to be provided with 8" high back splash, 2" return on 45

degree angle and 1" turned down, attach to wall with stainless steel Z-clips, 3" high X 1-3/4" rolled edges, stainless steel cross bracing, stainless steel legs and stainless steel adjustable flanged feet. All exposed back and end splashes to be enclosed, fully welded, ground and polished.

Each sink to be 28" long X 24" wide X 14" deep, provided with T&S Brass #B-3950-01 Waste Valve, twist handle and overflow assembly for 3-1/2" sink opening, 2" drain outlet and stainless steel lever waste bracket. Provide stainless steel skirt to cover sink bowls. Crease bottom of sink bowl to pitch to the drain. Sinks to be provided with 1" deep recessed perimeter to support removable stainless steel sink cover.

Unit to be further constructed in accordance with shop drawings.

APPROVED SHOP DRAWINGS REQUIRED PRIOR TO CONSTRUCTION.

A. T&S Brass Model B-0230-K Installation Kit, (2) 1/2" NPT nipples, lock nuts & washers, (2) short "Ell" 1/2" NPT female x male
B. T&S Brass Model B-0231-CR-KIT Pantry Faucet, double, wall mount, 8" centers, 12" swing nozzle, lever handles, stream regulator tip, quarter-turn Cerama cartridge, low lead, (2) 24" flex hose, 1/2" NPT, NSF, ADA Compliant
C. T&S Brass Model B-0133-ADF12-BJ EasyInstall Pre-Rinse Unit, with mixing faucet, includes 6" wall bracket, wall mount base, 8" centers, B-0044-H stainless steel flexible hose with polyurethane inner hose, overhead spring body & B-0107-J spray valve (1.07 gpm), 18" riser, add-on faucet with (062X) 12" swing nozzle, Eterna cartridges with spring checks, lever handles, 1/2" NPT female inlets

ITEM 17 - WIRE SHELVING
Metro Model 2448NK4 Dimensions: 48(w) x 24(d)
Quick Ship - Super Erecta® Shelf, wire, 48"W x 24"D, Metroseal™ Gray epoxy-coated corrosion-resistant finish with Microban® antimicrobial protection, plastic split sleeves are included with each shelf, NSF

A. Model 86UPK4 Super Erecta® SiteSelect™ Post, 85-7/8"H, for use with stem casters, Metroseal Gray epoxy coated corrosion-resistant finish with Microban® antimicrobial protection
B. Model 5PC Quick Ship - Super Erecta® Stem Caster, swivel, 5" dia., 1-1/4" face, 300 lb. capacity, corrosion resistant, polyurethane flat wheel tread, polymer horn, includes bumper
C. Model 5PCB Quick Ship - Super Erecta® Stem Caster, swivel (with foot operated brake), 5" dia., 1-1/4" face, 300 lb. capacity, corrosion resistant, polyurethane flat wheel tread, polymer horn, includes bumper

ITEM 18 - WIRE SHELVING
Metro Model 2442NK4 Dimensions: 42(w) x 24(d)
Quick Ship - Super Erecta® Shelf, wire, 42"W x 24"D, Metroseal™ Gray epoxy-coated corrosion-resistant finish with Microban® antimicrobial protection, plastic split sleeves are included with each shelf, NSF

A. Model 86UPK4 Super Erecta® SiteSelect™ Post, 85-7/8"H, for use with stem casters, Metroseal Gray epoxy coated corrosion-resistant finish with Microban® antimicrobial protection
B. Model 5PC Quick Ship - Super Erecta® Stem Caster, swivel, 5" dia., 1-1/4" face, 300 lb. capacity, corrosion resistant, polyurethane flat wheel tread, polymer horn, includes bumper

C. Model 5PCB Quick Ship - Super Erecta® Stem Caster, swivel (with foot operated brake), 5" dia., 1-1/4" face, 300 lb. capacity, corrosion resistant, polyurethane flat wheel tread, polymer horn, includes bumper

END OF SECTION 114000

SECTION 115313 - LABORATORY EQUIPMENT AND APPLIANCES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Work Results:

B. Principal Products:

C. Work of this Section includes all labor, materials, equipment and services necessary to complete the fume hoods, ventilation room filter banks, fume extractors, custom solvent storage cabinets, suspended in-painting lights and tracks, retractable coil reels, curtains, drying racks, light boxes, roll-down backdrop paper assemblies, shackles, brazing stations, and other equipment as shown and/or listed on the drawings and specified herein.

D. Related Requirements:
1. Division 23 Mechanical ductwork and controls.
2. Division 22 Plumbing.
3. Division 26 Electrical.
4. Division 06 Architectural Woodwork.
5. Electrical outlets, boxes, switches and lights, including wiring, within fume hood superstructures and for in-painting lights, and light boxes.
6. Cutting, filling, drilling of holes, reinforcing and other required work to enable the proper installation of mechanical equipment and service fixtures and other work to be done by other trades.
7. Division 05, Miscellaneous Metals and Structural Steel.

1.3 SUBMITTALS

A. General: Comply with Section 013300 Submittals.

B. Product Data: Submit manufacturer’s technical product data, installation instructions and general recommendations; include service connection requirements, performance criteria and standards, materials, manufacturer’s model numbers, furnished accessories, power/fuel requirements, control diagrams, details and other similar and suitable information. See also section 013300 2.2 for MFA required product submittal procedures and testing requirements.

C. Shop Drawings: Submit complete shop drawings (at least 3/4”=1’-0” scale) showing all elements including fume hoods, top/side/filler panels, filter frames, snorkels, bleaching light

assembly, in-painting light, custom fume extractor duct-supports, custom solvent cabinets, in painting lights and tracks, with all dimensions and also exact locations of all elements requiring coordination with other trades.

D. Samples: Provide the following samples:
   1. Finish samples, all materials.

1.4 QUALITY ASSURANCE

A. All equipment must be designed for use with - or provided with transformers for use with- 110 volt, 60 hertz, and carry the UL conformity marking.

B. Comply with all MFA stipulated product approval requirements noted in section 013300.

C. Fume Hood Performance Requirements:
   1. Fume hood shall be of special airfoil design to insure maximum operating efficiency and low-turbulence airflow. Foil sections at the front fascias of the hood shall minimize eddying of air currents at the hood face and the rear baffle system shall minimize turbulence in the upper portion of the hood interior.
   2. The Fume Hoods shall be a bypass model with variable volume compatibility, controlled to maintain a consistent, OSHA-approved low face velocity across the sash, regardless of location.
   3. The hoods shall be tested per the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Standard 110-95 and by the Auxiliary Air Capture Test.
      a. Hoods shall be tested with a face velocity of 80 FPM full open vertically. The hoods shall have a performance rating of 4.0 AM 0.01 or better wherein:
         1) 4.0 = tracer gas release in liters/minute AM = as manufactured.
         2) 0.01 = level of control of tracer gas in parts per million (ppm).

1.5 ENVIRONMENTAL QUALITY ASSURANCE

A. All proposed adhesives, sealants, caulking, woods and wood products, substrates, rubber products, coatings, fabrics and carpets shall be subject to MFA-stipulated specifications and submittal review to ensure that no noxious chemicals deleterious to art are introduced into their spaces. Special consideration should be given to provide building and fit-out materials containing the minimum possible quantities of urea formaldehyde, sulfer ammonia and/ or chlorine.

1.6 GUARANTEE

A. General: Comply with Section 01 78 36, Guarantees, Bonds, Service and Maintenance Contracts.

B. The equipment furnished under this section of the specifications shall guarantee for a period of one year from the date at which acceptance of the entire Work is certified by the Architect against defective materials, design and workmanship. Upon receipt of notice from the Owner

or the Architect or failure of any part of the guaranteed equipment during the guarantee period, the affected part or parts shall be replaced promptly and at the expense of the contractor. This guarantee shall also include one year's free services for all work furnished under this section.

1.7 PRODUCT HANDLING

A. Coordinate delivery of all elements of this section with delivery of other laboratory furniture components and other related work. Protect finish surfaces from soiling and damage during handling and installation. Keep covered with polyethylene film or other protective covering.

PART 2 PRODUCTS

2.1 MANUFACTURERS AND MODELS

A. Fume Hoods: This specification is based on Labconco Corporation products. Other products from Kewaunee or Fisher Scientific are acceptable if they meet or exceed all specified requirements, accessories, and features of specified units, and are approved in advance by the Architect.
   1. All hoods must pass ASHRAE 110-1995, with sash at 28" open, face velocity of 50 fpm, AM 0.01, AI/AU.
      a. 0.05. Hoods to carry the ETL Listed Mark for the following standards:
         1) UL 3101-1/61010-1.
         2) CAN/CSA C22.2 No. 1010.1.
         3) UL 1805.
   2. Hoods must conform to the current editions of the following standards:
      a. SEFA-1.
      b. NFPA 45.
      c. ASTM E84.
      d. ASHRAE 110-95.
      e. ANSI Z9.5 (Lab ventilation).
   3. Hoods must be designed for use with 110 volts, 60 hertz and carry the UL rating.
   4. All hoods shall be designed as bypass models, with velocities and flow levels optimized.
   5. All exterior surfaces of hoods, cabinets, panels etc. to be custom color to be determined by Architect.
   6. Provide two fume hoods from Labconco Corporation (or approved equal from Kewaunee): "Protector X Stream" high performance low flow Guardian VAV Fume Hoods (60" wide). Provide light fixtures, wiring & outlets. Provide solvent and acid storage cabinets as noted below. At each fume hood include three custom accessory closure panels (one front and two sides) extending up to 8'-0" a.f.f., whichever is taller. Fume hoods and accessories shall be as follows (or approved equal):
      a. Fume Hood # LCS-02.
         1) 1 1105-10020 "Protector XStream" high performance low flow bypass Fume Hood (60" wide) Add two duplex electrical receptacles, one on each side (gray with stainless steel. plates).
         2) 1 @ #9410300, Sash Stop/Kit.
         3) 1 @ #9503510, SpillStopper Work Surface (60" wide by 36" deep) (Left Cupsink).

4) 1 @ Front top panel 60” wide by 48” high, color to match fume hood; readily removable 2 @ Side top panels, 36” deep by 48” high, color to match hood.
5) 1@ #4005200 Oval Epoxy Cupsink.
6) 1 @ #9413400 Digital Guardian Airflow Monitor/Kit.
7) 1@ #9901200, Acid Storage Cabinet (30” x 22”).
8) 1 @ #9903200, Protector Solvent Storage Cabinet (30” wide with two doors) under the Fume Hood - must carry the Factory Mutual (FM) Listing and be tested and approved by Factory Mutual to meet Factory Mutual Approval Standard 6050. Cabinets must conform to NFPA 30 Chapter 4.3.3 (a): Storage Cabinets shall be designed and constructed to limit the internal temperature at the center, 1 inch (2.5 cm) from the top, to not more than 325 degrees F (162.8 degrees C) when subjected to a 10- minute fire test with burners simulating a room fire exposure using the standard time temperature curve as given in NFPA 251, Standard Methods of Fire Tests of Building Construction and Materials. All joints and seams shall remain tight and the door shall remain securely closed during the fire tests.
9) 2 @ #99203-10, Side Panels on side of storage cabinet.

b. Fume Hood # UCS-02:
1) 1 1105-10020 “Protector XStream” high performance low flow bypass Fume Hood (60” wide) Add two duplex electrical receptacles, one on each side (gray with stainless steel. plates).
2) 1 @ #9410300, Sash Stop/Kit.
3) 1 @ #9503510, SpillStopper Work Surface (60” wide by 36” deep) (Left Cupsink).
4) 1@ #9910000 Vent Kit.
5) 1@ #4005200 Oval Epoxy Cupsink.
6) 1@ #9413400 Digital Guardian Airflow Monitor/Kit.
7) 1 @ Front top panel 60” wide by 48” high, color to match fume hood; readily removable 2 @ Side top panels, 36” deep by 48” high, color to match hood.
8) 2 @ #9903200, Protector Solvent Storage Cabinet (two doors) (30” x 30”) under the Fume Hood - must carry the Factory Mutual (FM) Listing and be tested and approved by Factory Mutual to meet Factory Mutual Approval Standard 6050. Cabinets must conform to NFPA 30 Chapter 4.3.3 (a): Storage Cabinets shall be designed and constructed to limit the internal temperature at the center, 1 inch (2.5 cm) from the top, to not more than 325 degrees F (162.8 degrees C) when subjected to a 10- minute fire test with burners simulating a room fire exposure using the standard time temperature curve as given in NFPA 251, Standard Methods of Fire Tests of Building Construction and Materials. All joints and seams shall remain tight and the door shall remain securely closed during the fire tests.
9) 2 @ #99203-10, Side Panels on side of storage cabinet.

B. Provide spray filter bank frame with 3”x 3” WW mesh by Global Finishing Systems as detailed in drawings at Conservation Workroom. Provide 20” x 20” (Ad. white polyester Paint Pocket Overspray Arrestors, (by Global Finishing Systems). And provide MK II 25 manometer by Dwyer Instruments Inc. See drawings and details. Coordinate with galv. Sheet metal frame assembly sized and configured as shown on the Drawings by GC. Acceptable alternate manufacturers are Filter Frame by Camfil-Farr or Marathon Finishing Systems provided they meet or exceed the criteria mentioned above.

C. Provide two (2) lab stainless steel drying rack by Inter Dyne Systems (www.interdynesystems.com), Model #B2430, “Mod-Rack” Stainless Steel Pegboard. Pegboard to be constructed from 20 gauge type 304 stainless steel, polished to a #4 finish. Pegboard to include wall mount bracket and (32) 6” long polypropylene pegs. GC to provide blocking. See equipment schedule and elevations for locations. Acceptable alternate manufacturers are Fisherbrand (Fisher Scientific) or Kewaunee provided they meet or exceed the criteria mentioned above.

D. Provide one (1) lab stainless steel drying rack by Inter Dyne Systems (www.interdynesystems.com), Model “Victoria V4836” Stainless Steel Pegboard. Pegboard to be constructed from 20 gauge type 304 stainless steel, polished to a #4 finish. Pegboard to include wall mount bracket and (88) 6” long polypropylene pegs. GC to provide blocking. See equipment schedule and elevations for locations. Acceptable alternates are Fisherbrand (Fisher Scientific) or Kewaunee provided they meet or exceed the criteria mentioned above.

E. Curtain Tracks: Provide Straight and curved track above paper treatment sink at Level A Conservation Studio. Track and accessories to be Besteel series 173 by ADC Drapery Track Corp, Allentown, PA, (800-360-2321) as follows:
   1. #173 Track, 16 gauge extruded aluminum with clear anodized finish. 1-3/4”w x 2”h. See floor plans for lengths and locations.
   2. #1701 Single Carrier, plated steel construction with two heavy duty polyethylene wheels. Carriers to be spaced 6” o.c.
   3. #2209W End Stops for Walk Along Systems.

F. Curtains: Provide Rose Brand Black out curtain, in black. (NCMA to approve fabric choice.) Curtain to be at a minimum 50% fullness on track configuration as shown on drawings with straight and curved run and 9’-6” total height at Level A Conservation Studio. Hang from brushed aluminum grommets every 6” on center. Alternates shall meet or exceed the criteria mentioned above.

G. See Detail 1/A-431 for bleaching light assembly. Alternates shall meet or exceed the criteria mentioned in the details/schedule.

H. Provide two (2) under counter refrigerators and one (1) full height refrigerator/ freezers (see equipment schedule and drawings for locations) with stainless steel doors. Install in close coordination with millwork (and other trades as may be required).

I. Custom Solvent Storage Cabinet, one (1) at 5’-0” wide x 7’-6” tall x 30” deep by Securall or approved equal (www.securallproducts.com). Custom storage solvent cabinets shall be specifically designed for the storage of flammable and combustible liquids. Construction shall be based upon the requirements listed by UL, UFC, OSHA, and for NFPA No. 30 certification. The bottoms, top, sides and doors shall be fabricated of 18 gauge steel and shall be all double panel construction with a 1-1/2” air space between panels. All joints shall be electrical arc welds and seams should be held by resistance spot welds and continuous electric arc welds; any remaining joints to be screwed in order to provide a rigid enclosure. The liquid-tight self-closing, self-latching Safe-T-Doors shall have fusible links to hold them in the open position. At 165 degrees Fahrenheit, the fusible links shall melt, thus closing the doors. The doors shall swing on full-length 18 gauge galvannealed steel piano hinges and shall be fully insulated. Seven (7) full-depth adjustable shelves, each with a 500 lbs load capacity, and one removable,

full size drip pan (3 inches deep) shall be provided at cabinet. The shelves shall be perforated to allow free air circulation within the cabinets. Each cabinet will have a liquid tight door sill extending 2” above the bottom of the cabinet that is electrically arc welded. One(1) 6” dia. vent with spark screen shall be provided in the front of each door of each cabinet as well as a grounding screw. One (1) 8” dia. collar for duct connection shall be located at the top or back (see drawings for exact locations). Each cabinet shall measure and be configured as per the drawings, and have adjustable steel leveling legs; 3/8” - 16 x 2” lg, zinc plated, 4 per cabinet. Each cabinet should be powder coated inside and out with two coats of high solids urethane. Custom color as per Architect. Any warning labels and product information labels are to be according to code, and made of solvent-resistant, pressure-sensitive, vinyl with self- adhesive backing or painted on. Such signs will be red lettering. See equipment schedule and floor plans for locations. Acceptable alternate manufacturers are Justrite or Eagle provided they meet or exceed the criteria mentioned above.

J. Provide eight (8) KUA-160/4H articulated snorkels with white hose masterduct, and black hose elbows with 3 position switches (off-low-high) and manual damper at inlet, as manufactured by Plymovent or approved equal. Coordinate fully with mechanical and controls trades, and with custom galvanized steel support bracket/duct assemblies (see Division 5, above). Provide tissue screen at inlets. Variable speed potentiometer control shall be provided at wall location as noted on drawings. (Fans, controls, and automatic dampers by mechanical trade). Maximum of 2.5” pressure drop through the snorkel, including all accessories. Straight runs shall be custom white color with black elbows. Acceptable alternate manufacturers are Movex provided they meet or exceed the criteria mentioned above.

K. Provide one (1) large manual photographic Backdrop Support Systems (12’w) at Examination Room. Bogen #2921 B/P Triple Hooks set with three (3) Bogen #046MC Expan with Metal Chain and three (3) Bogen #2925 Chain Weight. Available via Bogen Photo Corp., 565 E. Crescent Ave., P.O. Box 506, Ramsey, NJ 07446- 0506, or approved equal. See drawings for location and mounting. Acceptable alternate manufacturers are Manfrotto or Impact provided they meet or exceed the criteria mentioned above.

L. Provide four (4) 45’-0” long, retractable 20 amp electrical cord reels secured directly to the underside of the roof slab at Level B conservation. Hubbell Gleason Reel 20 amp cord reel - Model ACA12445W(White) with a single 20amp receptacle Model ACA12345-SR20 and a mounting bracket - Model HBLIMB. Acceptable alternate manufacturers are Coxreels or Reelcraft provided they meet or exceed the criteria mentioned above.

M. Provide large, custom stainless steel treatment sink and base cabinets. The sink and base cabinet shall be custom fabricated for this project, and shall be installed complete with all trimmings and fittings. Refer to architectural drawings for plan, elevations, location of fixtures. Also refer to Plumbing Drawings.
   1. The published standards of the National Sanitary Foundation, Underwriter’s Lab, OSHA, and this project’s referenced plumbing standards will be considered as minimum requirements for equipment and installation of same. All equipment shall be manufactured and installed in accordance with these standards.
   2. Materials (General).
      a. All stainless steel comprising the sink itself shall be #18-8 containing not less than 18% chrome, not less than 8% nickel and not more than 0.08% carbon content of United States Standard Gauge, Type 316 with not less a #4 mill finish on

all exposed surfaces. All fabricated equipment to have lines of mill finish run horizontally. No material lighter than #18 gauge stainless steel shall be used on fabricated equipment. All welding wire used shall be Type 308L. All sheets shall be free of buckles, warps and surface imperfections. For the base cabinet (including drawers, doors, shelves, and basic assembly) Type 304 stainless with #4 finish is acceptable.

b. Where galvanized iron is called for, it shall be galvanized on an 8% copper bearing alloy sheet with an approved hot pure zinc galvanizing. Where galvanized iron has been welded, all seams shall be cleaned and scaled removed and finished with a prime coat of aluminum paint.
c. Where white metal is specified, a white metal (commercially known as nickel silver) casting is intended. Such metal to be of occupation resistant quality and shall contain not less than 30% nickel. All castings shall be rough ground, polished and buffed to a bright luster, free from pits, cold runs, checks, burrs or other surface imperfections.
d. Wherever stainless steel pipe or tubing is specified, it shall be seamless, of gauge specified and of true roundness. All tubing where exposed to view shall be given a final grind of not less than 180 grit emery.
e. All angles, bands, channels or other structural shapes used for framing shall be of domestic manufacture, uniform and ductile in quality. Where such sections are specified as galvanized, they shall be galvanized by the hot dip process, with all excess spelter removed, and be smooth and free from cold runs, blisters, uncoated or scaly patches.
f. Wherever equipment is provided with handles, knobs, hinges, brackets or other miscellaneous hardware, all shall be of either white metal or stainless steel of metallurgical composition previously specified. (Submit samples of all proposed handles, knobs, hinges and other hardware for Architect’s approval.).

3. Materials (Specific).
   a. (Welding) All welding of stainless steel shall be done by the electric heliarc process. Carbon arc will not be permitted. All welding of galvanized iron shall be done by electric fusion-arch method. All welding shall be done in a through manner. Welds shall be complete welds, strong as sheets or parts welded. Welds shall be complete welds, strong and ductile, with excess metal ground off and joints finished smooth to match adjoining surfaces. Welds are to be free of mechanical imperfections such as gas holes, pits, runs, cracks, etc. and shall have same color as adjoining sheet surfaces. All joints in tops of fixtures, tables, drain boards, exposed shelving, sinks, front and ends of cabinets exposed to view, etc. shall be full penetration welds. Butt welds made with solder and furnished by grinding shall not be acceptable.
   b. (Welding) All welded joints shall be homogenous with the sheet metal itself. Where sheet sizes necessitate a joint, such joint shall be welded. All fixtures shall be fabricated in the factory with welded joints to reduce field joints to a minimum. Wherever welds occur on surfaces not fished by grinding and polishing, such welds and the accompanying discoloration shall be suitably coated in the factory by means of metallic base paint to prevent the possibility of progressive corrosion at such points. All field joints shall be continuously welded, ground smooth and polished.
   c. (Soldering) Soldering where required or permitted, shall be done with a solder consisting of 75% pure tin and 25% lead. Stainless steel requiring soldering shall be first thoroughly cleaned of surface oxides and shall then have applied a suitable stainless steel soldering flux. After the soldering has been completed, excess or remaining flux shall be removed and the entire soldered joint cleaned with liquid

alkaline to prevent any attack of the stainless steel by the soldering flux.

d. (Grinding, Polishing, Finishing) All exposed welded joints shall be suitably ground flush with the adjoining material and neatly finished to harmonize therewith. Wherever material has bee sunken or depressed by a welding operation, such depressions shall be suitably hammered and peened flush with the adjoining surface, and if necessary, again ground to eliminate low spots. All ground surfaces shall then be polished or buffed to match adjoining surfaces consistent with good workmanship. Care shall be exercised in grinding operations to avoid excessive heating of the metal and metal discolorations. In all cases, the grain of rough grinding shall be removed by successive finer polishing operations. The texture of the final polishing operation shall be uniform and smooth consistent with reasonable care and good workmanship. The finish of all equipment shall be of a high grade as specified herein.
e. (Grinding, Polishing, Finishing) Butt joints and contact joints, wherever they occur, shall be close fitting. Wherever brake bends occur, they shall be free of undue extrudence and shall not be flaky, scaly or cracked in appearance; and where such brake work does mark the uniform surface appearance of the material, all such marks shall be removed by suitable grinding, polishing and finishing. Wherever sheared edges occur, they shall be free of burrs, fins, or irregular projections and shall be finished to obviate all danger of cutting or laceration when the hand is drawn over such sheared edges. Where miters or bull nosed corners occur, they shall be neatly finished with under edge of material neatly ground to a uniform condition and in no case are overlapping materials to be acceptable.
f. (Grinding, Polishing, Finishing) All exposed surfaces shall have a #4 ground finish except trim which is to be of a more highly polished satin finish. Where specified, all cabinets, doors, shelves whether inside or outside of cabinets and wherever exposed to view are to be #4 finish. This applies to inside finish of any cabinet having doors or otherwise. An exposed surface shall be interpreted as meaning an inside surface exposed to view when a sliding door or swinging door is opened. The under side of shelf need not be #4 finish, but such surfaces shall be at least equal to #80 ground finish. The tops of tables, sinks, dish tables, where manufacturing operations and welding disturb the original #4 finish shall be finished in a satin finish.
g. (Grinding, Polishing, Finishing) Deliver all stainless steel equipment to the job covered with adequate protection and covering. Remove this protection when directed, and restore any surfaces which are scratched or marred, to their original finish.

N. At Conservation Workroom 258E, provide AWD-AUTO automatic area warning device for laser use by Kentek Corporation (contact Paul Dixon, pdixon@centeklaserstore.com) as shown in drawings & coordinate for adjacent outlet installation to feed the warning device. Provide Light-It illuminated laser safety warning sign with ceiling mounting kit, also by Kentek Corp, outside room 258E as shown on drawings. Laser safety warning sign to be hardwired through the wall to connect with the automatic warning device. See Architectural and Electrical drawings.

PART 3 EXECUTION

3.1 INSPECTION

A. Inspect existing conditions prior to delivery and notify Owner and Architect immediately of any condition detrimental to the satisfactory installation of work of this section.

3.2 INSTALLATION

A. General: Install all elements plumb, level, rigid, securely anchored to building or adjacent furniture in proper location, in accordance with manufacturer's instructions. Install closures neatly. Securely attach access panels but provide for easy removal and secure re-attachment. Provide grounding from the fume hoods and solvent cabinets to the building’s plumbing system. Coordinate fully with miscellaneous metals, millwork, mechanical and controls trades.

3.3 FIELD QUALITY CONTROL

A. Field Test: Field test each unit after completion of installation to verify proper operation in accordance with specified requirements. Perform fume hood tests in accordance with Section 7 of Scientific Apparatus Makers Association Standard LF-10.

3.4 ADJUST AND CLEAN

A. Moving Parts: Carefully check to insure smooth, near-silent, and accurate operation; sash operation with one hand with uniform contact of rubber bumpers; counterbalances operate without interference. Adjust all snorkel linkages to ensure that snorkels stay in intended positions without drifting. Installer shall make required adjustments on all snorkels prior to substantial completion and shall return at Final Completion for any required re-adjustment at no additional cost.

B. Clean all surfaces.

C. Damaged Work: Repair equal to new undamaged work, or replace with new units, as acceptable to Architect.

D. Protection: During the installation and until the acceptance by the Owner of all work of this Section, adequately protect all items from damage.

3.5 CONSTRUCTION WASTE MANAGEMENT

A. General: Comply with the requirements of Section 01 74 19 Construction Waste Management for removal and disposal of construction debris and waste.

B. Separate and recycle waste materials to the maximum extent possible.

END OF SECTION 115313

SECTION 122413 - WINDOW SHADES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Work Results:

B. Principal Products:

C. Work of this Section includes all labor, materials, equipment, and services necessary to complete the window shades as shown on the drawings and/or specified herein, including, but not limited to, the following:
   1. Manually-operated window shades.
   2. Electrically-operated window shades.
   3. Electrically-operated skylight shades.
   4. Field measurements of as-built conditions.
   5. Accessories and hardware required for complete installation and operation.

1.2 RELATED SECTIONS

A. Electrical - Division 26.

1.3 QUALITY ASSURANCE

A. Provide assemblies which are complete assemblies produced by one manufacturer, including hardware, accessory items, mounting brackets, and fastenings.

B. Provide materials in colors as selected by the Architect from manufacturer's standard colors.

C. Fire-Test-Response Characteristics: Passes NFPA 701-99 small and large-scale vertical burn. Materials tested shall be identical to products proposed for use.

D. Electrical Components: NFPA Article 100 listed and labeled by either UL or ETL or other testing agency acceptable to authorities having jurisdiction, marked for intended use, and tested as a system. Individual testing of components will not be acceptable in lieu of system testing. Where applicable, system components shall be FCC compliant.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions.
   1. Motorized Shade Operators: Include operating instructions.
   2. Motors: Show nameplate data, ratings, characteristics, and mounting arrangements.

B. Shop Drawings: Submit floor layout and elevations, indicating location of all window treatments, mechanism details, type and size of each unit, type and location of controls. Shop drawings must also show seaming of shade fabric. Submit shop drawings showing details of installation and relation to adjoining construction and conditions.

C. Samples: Submit full size sample of each shade type for Architect's acceptance.

D. Mock-Up.
   1. Install each type of shade assembly on one complete column bay for Architect's acceptance of installation details, workmanship and operation.
   2. Approved mock-up shall be used as the standard for installation of work under this Section, and no further installation work shall proceed before Architect's acceptance of the mock-up.

1.5 WARRANTY

A. Manufacturer’s standard non-depreciating 25-year limited warranty covering all hardware, chains, motors, motor control system and shade cloth.

1.6 DELIVERY, STORAGE AND HANDLING

A. Protect shades from damage, soiling and deterioration during transit, storage and handling until Owner's acceptance.

PART 2 PRODUCTS

2.1 MANUALLY OPERATED SHADES

A. Provide manually operated shade system equal to "Mechoshade/5 System," made by the Mecho-Shade Corp. or equal made by Sol-R-Veil Inc., Draper, or approved equal conforming to standards specified herein.

B. Shade system shall be pre-engineered overrunning clutch design that disengages to 90% during the raising and lowering of the shade. The brake can stand a pull force of 40 lb. in the stop position. Requires no adjustment. Self-lubricating hub on to which the brake system is mounted includes an articulated brake assembly which assures smooth, non-jerky operation in raising and lowering the shades. System shall include the following components:
   1. Provide shade hardware allowing for the removal of shade roller tube from brackets without removing hardware from opening and without requiring end or center supports to

be removed.
2. Provide shade hardware that allows for removal and remounting of the shade bands without having to remove the shade tube, drive or operating support brackets.
3. Provide for universal, regular and offset drive capacity, allowing drive chain to fall at front, rear or non-offset for all shade drive end brackets. Universal offset shall be adjustable for future change.
4. Provide shade hardware system that allows for removable regular and/or reverse roll fascias to be mounted continuously across two or more shade bands without requiring exposed fasteners of any kind.
5. Provide shade hardware system that allow for operation of multiple shade bands (multi-banded shades) by a single chain operator. Connectors shall be offset to assure alignment from the first to the last shade band.
6. Provide shade hardware constructed of minimum 1/8" thick plated steel or heavier as required to support 150% of the full weight of each shade.
7. Drive Bracket/ Brake Assembly:
   a. MechoShade Drive Bracket M5 or equal by other manufacturers noted herein.
   b. Drive Chain: #10 qualified stainless steel chain rated to 90 lb.
   c. Minimum Breaking Strength: Nickel plate chain shall not be accepted.
8. Shade Pockets:
   a. Provide shade pocket #4133 Surface Mounted Pocket by Mechoshade for surface mounted single roll shades.
   b. Provide shade pocket #4123 Recessed Pocket by Mechoshade for recessed single roll shades.
   c. Provide 6113 Recessed Pocket by Mechoshade for recessed double shades.

C. Shade Bands: Construction of shade band includes the fabric, the hem weight, hem pocket, shade roller tube, and the attachment of the shade band to the roller tube. Sewn hems and open hem pockets are not acceptable.
1. Hem Pockets and Hem Weights: Fabric hem pocket with RF welded seams (including welded ends) and concealed hem weights. Hem weights shall be of appropriate size and weight for shade band. Hem weight shall be continuous inside a sealed hem pocket. Hem pocket construction and hem weights shall be the same, for all shades within one room.

2.2 ELECTRICALLY OPERATED SHADES

A. Provide electrically operated shade system equal to "ElectroShade" made by the MechoShade Corp. or equal made by Sol-R-Veil Inc. or approved equal conforming to standards specified herein.

B. Access and Material Requirements:
1. Provide shade hardware allowing for the removal of shade roller tube from brackets without removing hardware from opening and without requiring end or center supports to be removed.
2. Provide shade hardware that allows for removal and remounting of the shade bands without having to remove the shade tube, drive or operating support brackets.

C. Motorized Shade Hardware and Shade Brackets:
1. Provide shade hardware constructed of minimum 1/8" thick plated steel, or heavier,

thicker, as required to support 150% of the full weight of each shade. Plastic components without use of steel angle construction do not meet the intent of this specification and shall not be accepted.

2. Provide shade hardware system that allows for field adjustment of motor or replacement of any operable hardware component without requiring removal of brackets, regardless of mounting position (inside, or outside mount).
3. Provide shade hardware system that allows for operation of multiple shade bands offset by a maximum of 8-45 degrees from the motor axis between shade bands (4-22.5 degrees) on each side of the radial line, by a single shade motor.
    a. Provide one shade band per window unit up to six shade band units per motor.
    b. All shade bands within a single motor group shall be aligned within ¼".
4. Shade Pockets:
    a. Provide shade pocket #4133 Surface Mounted Pocket by Mechoshade for surface mounted single roll shades.
    b. Provide shade pocket #4123 Recessed Pocket by Mechoshade for recessed single roll shades.
    c. Provide 6113 Recessed Pocket by Mechoshade for recessed double shades.

D. Shade Motors:
1. Intelligent Encoded Motor and Control System: Tubular, asynchronous (non-synchronous) motors, with built-in reversible capacitor operating at 110v AC (60 Hz), single phase, temperature Class A, thermally protected, totally enclosed, maintenance free with line voltage power supply equipped with locking disconnect plug assembly furnished with each motor.
2. Conceal motors inside shade roller tube.
3. Maximum current draw for each shade motor of 2.3 amps.
4. Use motors rated at the same nominal speed for all shades in the same room.

E. Intelligent Encoded Motor System:
1. Upper and lower stopping points (operating limits) of shade bands shall be programmed into motors via a hand held removable program module/ configurator.
2. Intermediate stopping positions for shades shall be a minimum of 4 predefined intermediate positions, for a total of 6 defined and aligned positions. All shades on the same switch circuit with the same opening height shall align at each intermediate stopping position.
3. Encoded Motors shall be addressable via a hand held removable program module and shall be capable of responding to a minimum of seven different user defined stored addresses including multiple overlapping sub groups and three reserved control input address for use by building management systems, life safety systems and other emergency inputs.
4. The system shall have the capability of two-way communication with the motors. Each motor shall allow for a unique address message to be received from the hand held configurator and/or a PC controller or switch.
    a. Bus line shall consist of 2 twisted pair of 16 gauge low voltage wire.
    b. Shade motor control components (bus interfaces, wall switches, bus supplies, auxiliary control input devices) shall be connected in series via the low voltage (12 VDC) two way digital communication bus lin.
    c. Bus line shall be capable of being installed I a free topology to provide maximum flexibility for installation and future maintenance.

d. Low voltage (12VDC), digital bus line shall be powered by a bus supply transformer, requiring 115VAC (220-230 VAC) input drawing a maximum current of 1 amp. A minimum of one bus supply shall be required for every 400 linear feet of bus line. Final bus supply spacing shall be reviewed with the system manufacturer after the number of nodes per 400 ft. run of bus line has been determined.

5. Wall Switches:
   a. Where noted shades shall be operated by a 4 and 8 button low voltage standard switches or programmable intelligent switches (IS). Standard switch shall be wired to a bus interface and the bus interface will be programmed to transmit an address for the local switch.
   b. Intelligent switches may be installed anywhere on the bus line. Each IS shall be capable of storing one control level address to be broadcast along the bus line.
   c. An address that is transmitted by either a switch or central controller shall be responded to by those motors with the same address in their control table.
   d. IS shall provide for interface with other low voltage input devices via a set of dry contact terminals located on the switch.
   e. Standard switch or IS may control an individual, sub-group or group of motors in accordance with the address in each motor.

F. Shade Band: As described herein for manual shades.

G. Finishes: Unless otherwise noted, all exposed aluminum parts have an anodized finish. Steel parts are either nickel plated, satin finish, or have been bonderized prior to painting with a baked, enamel finish.

H. Side Channels: Provide standard "blackout" side channels where noted. Channels shall be extruded aluminum, with a standard anodized finish, color selected by the Architect. At blackout shades without side channel, ensure shadecloth overlaps window frame.

2.3 SHADE CLOTH

A. Basketweave Shade Cloth: Shade cloth shall be "EuroTwill Reversible 6000 Series" as manufactured by MechoShade, or approved equal; 3% open, color Dove Grey 6009.

B. Black-out Shade Cloth: Shade cloth shall be "Equinox 0100 Series" opaque acrylic black-out shade cloth made by MechoShade, or approved equal; color 0105 Silver.

2.4 FABRICATION

A. The shade and the fabric shall hang flat without buckling or distortion. The edge, when trimmed, shall hang straight without curling or raveling. An unguided roller shade cloth shall roll true and straight, without shifting sideways more than +/- 1/8" in either direction due to warp distortion or weave design. Shades shall fill window openings from head to sill and jamb to jamb.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where window treatments are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 INSTALLATION: GENERAL

A. Coordinate with the work of other trades to assure proper and adequate provision in the work of those trades for interface with the work of this Section.

B. Install the work of this Section in strict accordance with the indicated design and the installation recommendations of the manufacturer as approved by the Architect.

C. Upon completion of the installation, put all components through at least ten (10) complete cycles of operation, adjusting as necessary to achieve optimum operation.

3.3 INSTALLATION OF MANUAL ROLLER SHADES

A. Install roller shades level, plumb, square, and true according to manufacturer’s written instructions and located so shade band is not closer than 2" to interior face of glass. Allow proper clearances for window operation hardware.

B. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

C. Clean roller shade surfaces after installation, according to manufacturers written instructions.

3.4 INSTALLATION OF MOTOR OPERATED SHADES

A. Install roller shades level, plumb, square, and true according to manufacturer’s written instructions and located so shade band is not closer than 2" to interior face of glass. Allow proper clearances for window operation hardware.

B. To control the responsibility for performance of motorized roller shade systems, the Contractor shall assign the engineering, and installation of motorized roller shade systems, motors, controls, and low voltage electrical control wiring specified in this Section to a single manufacturer and his authorized installer/dealer. The Architect will not produce a set of electrical drawings for the installation of control wiring for the motors, or motor controllers of the motorized roller shades. Power wiring (line voltage), shall be provided by the roller shade installer/dealer, in accordance with the requirements provided by the manufacture. Coordinate the following with the roller shade installer/dealer:
   1. Contractor shall provide power panels and circuits of sufficient size to accommodate roller shade manufacturer’s requirements, as indicated on the mechanical and electrical

drawings.

2. Contractor shall coordinate with requirements of roller shade installer/dealer, before inaccessible areas are constructed.
3. Roller shade installer/dealer shall run line voltage as dedicated home runs (of sufficient quantity, in sufficient capacity as required) terminating in junction boxes in locations designated by roller shade dealer.
4. Roller shade installer/dealer shall provide and run all line voltage (from the terminating points) to the motor controllers, wire all roller shade motors to the motor controllers, and provide and run low voltage control wiring from motor controllers to switch/control locations designated by the Architect. All above ceiling and concealed wiring shall be plenum rated, or installed in conduit, as required by the electrical code having jurisdiction.
5. Contractor shall provide conduit with pull wire in all areas, which might not be accessible to roller shade contractor due to building design, equipment location or schedule.

C. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

D. Clean roller shade surfaces after installation, according to manufacturers written instructions.

E. Engage installer to train Owner's maintenance personnel to adjust, operate and maintain roller shade systems.

3.5 PROTECTION AND CLEANING

A. Protect installed units to ensure proper operating condition, without damage or blemishes. Repair or replace damaged units as directed by the Architect.

END OF SECTION 122413

SECTION 123662 - QUARTZ COUNTERTOPS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Quartz countertops.

1.2 ACTION SUBMITTALS

A. Product Data: For countertop materials.

B. Samples for Verification: For the following products:
   1. Countertop material, 6 inches square.

C. Shop Drawings:
   1. Plans, sections, details, edge and backsplash profiles, and attachments to other work.
   2. Locations and details of joints.
   3. Direction of veining, grain, or other directional pattern.
   4. Locations and sizes of cutouts and holes for items installed in countertop.

D. Samples: For each stone type, in sets not less than 12 inches (300 mm) square.
   1. Include two or more Samples in each set and show the full range of variations in appearance characteristics expected in the completed Work.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For quartz agglomerate countertops.Include product data for care products used or recommended by Installer, and names, addresses, and telephone numbers of local sources for products.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate countertops similar to that required for this Project, and whose products have a record of successful in-service performance.

B. Installer Qualifications: Fabricator of countertops.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store and handle stone and related materials to prevent deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping, and other causes.
   1. Lift stone with wide-belt slings; do not use wire rope or ropes that might cause staining. Move stone, if required, using dollies with cushioned wood supports.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify dimensions of countertops by field measurements after base cabinets are installed but before countertop fabrication is complete.

1.8 COORDINATION

A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 PRODUCTS

2.1 QUARTZ AGGLOMERATE COUNTERTOP MATERIALS (Q-)

A. Quartz Agglomerate: Solid sheets consisting of quartz aggregates bound together with a matrix of polymers, resins, and pigment and complying with ISFA 3-01.
   1. Manufacturers: Subject to compliance with requirements, provide Basis of Design product or comparable product indicated on drawings.
   2. Edge Profile: As indicated on Drawings.

2.2 FABRICATION

A. Fabricate stone countertops in sizes and shapes required to comply with requirements indicated.
   1. Fabricate countertops according to quartz agglomerate manufacturer's written instructions and the AWI/AWMAC/WI's "Architectural Woodwork Standards."
      a. Grade: Premium.
   2. Countertops: See Drawings for thicknesses and edge profiles.

B. Joints:
   1. Fabricate countertops in sections for joining in field coordinate joint locations with Architects in Shop Drawings.
   2. Joint Locations: Not within 18 inches (450 mm) of a sink and not where a countertop section less than 36 inches (900 mm) long may result, unless unavoidable.
   3. Joint Type, Bonded: 1/32 inch (0.8 mm) or less in width.

C. Cutouts and Holes:
   1. Undercounter Fixtures: Make cutouts for undercounter fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.
      a. Provide vertical edges, slightly eased at juncture of cutout edges with top and

bottom surfaces of countertop and projecting 3/16 inch (5 mm) into fixture opening.

b. Provide vertical edges, rounded to 3/8-inch (10-mm) radius at juncture of cutout edges with top surface of countertop, slightly eased at bottom, and projecting 3/16 inch (5 mm) into fixture opening.

c. Provide 3/4-inch (20-mm) eased edge for edges projecting 3/8 inch (10 mm) into fixture opening.

2. Counter-Mounted Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.

3. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.

2.3 INSTALLATION MATERIALS

A. Adhesive: Product recommended by quartz agglomerate manufacturer.

B. Sealant for Countertops: Comply with applicable requirements in Section 079200 "Joint Sealants."

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates to receive stone countertops and conditions under which stone countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of stone countertops.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install countertops level to a tolerance of 1/8 inch in 8 feet (3 mm in 2.4 m), 1/4 inch (6 mm) maximum. Do not exceed 1/64-inch (0.4-mm) difference between planes of adjacent units.

B. Secure countertops to subtops with adhesive according to quartz agglomerate manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with quartz agglomerate manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

C. Bond joints with stone adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.

1. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.

D. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Use power saws with diamond blades to cut stone. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless

beveling is required for clearance. Ease edges slightly to prevent snipping.

E. Install backsplashes and end splashes by adhering to countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.

F. Apply sealant to gaps at walls; comply with Section 079200 "Joint Sealants."

G. Retain "Inspections" Paragraph below to require inspection of installed Work by either AWI or WI. Under both AWI and WI quality programs, Architect has the right to request an inspection at any time during Project.

END OF SECTION 123662

SECTION 126100 - FIXED AUDIENCE SEATING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes fixed plastic chairs with self-rising seat mechanisms, aisle and intermediate stanchions with the following typical applications:
   1. Floor mounted chairs.
   2. Riser mounted chairs.

1.3 DEFINITIONS

A. Shell: An exposed, supporting seat bottom or back made of materials other than steel.

1.4 COORDINATION

A. Coordinate layout and installation of electrical wiring and devices with seating layout to ensure that floor junction boxes for electrical devices are accurately located to allow connection without exposed conduit.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of components, and finishes for fixed audience seating.

B. Shop Drawings:
   1. Include plans, elevations, sections, and attachment details.
   2. Seating Layout: Show seating layout, aisle widths, aisle-end alignment or stepping, row-lettering and chair-numbering scheme, chair widths, and chair spacing in each row.
   3. Accessories: Show locations and features of accessories, including electrical devices, and accessibility provisions.

C. Samples for Initial Selection: For each type of exposed color, finish, texture, and pattern indicated.
   1. Include Samples of accessories involving color and finish selection.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:
   1. Chair Unit: Full-size unit of each type and combination of finishes.
   2. Row-Letter and Chair-Number Plates: Full-size units with letters and numbers marked.
   3. Full-size samples of chair units, if approved, will be returned to Contractor for use in Project.

1.7 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of fixed audience seating.

B. Material Certificates: For each type of flame-retardant treatment of upholstery fabric.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fixed audience seating to include in operation and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
      a. Maintenance of self-rising seat mechanisms and other operating components.
      b. Adjustment of self-rising seat mechanisms to align seats.
      c. Precautions for cleaning materials and methods that could be detrimental to seating finishes and performance.

1.9 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same production run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Complete Seat Component (total of 5).
   2. Complete Back Component (total of 5).
   3. Complete Intermediate support (total of 5).
   4. Complete Aisle Panel (3 Right facing/ 3 Left facing).

1.10 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
   1. Build mockups of two typical seats in width and two typical rows deep, including finishes and accessories:
   2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Final Acceptance.

1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of fixed audience seating that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including standards, beams, and pedestals.
      b. Faulty operation of self-rising seat mechanism.
      c. Wear and deterioration of plastic finish beyond normal use.
      d. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
   2. Warranty Periods: As follows, from date of Final Acceptance.
      a. Structural: 10 years.
      b. Operating Mechanisms: Five years.
      c. Plastic and Paint Components: Five years.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of seating required, including accessories and mounting components, from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:
   1. Seat:
   2. a. Polyethylene shall meet the Federal Motor Vehicle Safety Standard No. 302 which specifies a burning rate of less than 4 inches per minute.

B. Strength and Durability Performance:

C.
   1. Chairs and components shall pass testing according to BIFMA X5.4.
   2. Seat shall be tested and professionally certified through an independent testing laboratory to support and withstand an evenly distributed 600 lb. 272.1Kg static load without failure

or irregularities that would impair usefulness.

3. Self-lifting seat shall be tested and professionally certified through an independent testing laboratory to withstand 350,000 operating cycles without added lubrication, spring fatigue, adjustment, or measurable bearing wear.
4. Seat shall be tested and professionally certified to withstand, without failure, 10,000 impacts of a 40 lb. 18.14Kg sandbag dropped on the center of seat from each of the following heights of 6 inches 152mm, 8 inches 203mm, 10 inches 254mm, 12 inches 305mm at a rate of 18 impacts per minute for a total of 40,000 impacts.
5. Back shall be tested and professionally certified through an independent testing laboratory to withstand an evenly distributed front or rear static load of 450 lb. 204.08Kg.
6. Back shall be tested and professionally certified to withstand, without failure, 40,000 swinging impacts each to the front and rear of the back by means of two opposing 40 lb. 18.14Kg sandbags. The sandbags shall be moved horizontally and equally for 10,000 cycles each at the following distances of 6 inches 152mm, 8 inches[203mm], 10 inches 254mm, and 12 inches 305mm at a rate of 18 cycles per minute.
7. Horizontal Traverse Static Load to Back: Backs shall withstand an evenly distributed static load of 200 lbs 90.70Kg to the top of the back at a 45 degree angle to the row of seats.
8. Armrests shall be tested and professionally certified to withstand an evenly distributed static load of 200 lbs 90.70Kg applied perpendicular to the armrest.

2.3 FIXED AUDIENCE SEATING

A. Description: Assembly-space seating in permanent arrangement as indicated on Drawings.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide “Fusion” by Hussey Seating Company, USA. or comparable product by one of the following:
      a. Interkal,
      b. Irwin Seating Company.
      c. Davis Furniture Company.

B. Chair Mounting Standards: Floor attached of the following material:
   1. Steel: One-piece, heavy-tube or reinforced sheet with welded mounting plate and welded connections for seat pivots, backs, armrests, and end panels.
   2. Intermediate Supports: Intermediate support frames shall be 14-gauge, cold rolled, de-scaled, and welded structural steel tubing with a 1/4” foot plate, continuously welded to the tubing for mounting the hinge mechanism. The foot support plate shall be 1/4” thick steel, continuously welded into one integral freestanding structure upon which the seat is installed. The floor mounting plate provides four holes, two selected diagonally for initial concrete installation.

C. Chair Width: Vary chair widths to optimize sightlines and row lengths, with minimum chair width of 20 inches (508 mm) from center to center of armrests.

D. Back Type: Plastic.

E. Seat Type: Plastic.

F. Stanchions: Riser Mounted.

G. Back Pitch: Fixed.
   1. Back Angle: Different angles within manufacturer's available range, for optimum viewing comfort at each location.

H. Chair Seat Hinges: Self-lubricating, with noiseless self-rising seat mechanism passing ASTM F851, positive internal stops cushioned with rubber or neoprene, and requiring no maintenance.
   1. Self-Rising Seat Mechanism: Spring actuated, full fold.
   2. Seat Performance Testing - Seats shall be certified to withstand 300,000 lifting cycles, 600 lbs. static load placed at 3” from the front of the seat and vertical drop impact with 40 lbs. from 6” 8” 10” and 12”, 25,000 times each at a rate of 18 cycles per minute for a total of 100,000 impacts without failure.

I. Row-Letter and Chair-Number Plates: Manufacturer's standard.
   1. Material: Aluminum with black embossed characters.
   2. Location: chair number on front edge of seat.
   3. Attachment: Manufacturer's standard method.

J. Product Accessories: Seat numbers, Row letters, Donor plates, ADA easy access armrest, ADA armless stanchion.

2.4 MATERIALS AND FINISHES

A. Cast Aluminum: Aluminum Alloy AA 380.

B. Cast Iron: ASTM A48 and ASTM A536.

C. Drilled-in Expansion Anchors: SAE grade 2.

D. Blow molded plastic: Virgin high-density polyethylene with a melt index of 0.40 per ASTM D1238.
   1. Color: As selected by Architect from manufacturer's full range.

E. Metal Finish: Finish exposed metal parts with minimum 1.5-mil- (0.04-mm-) thick, epoxy baked-on powder coating.
   1. Color: As selected by Architect from manufacturer's full range.

2.5 FABRICATION

A. Floor Attachments: Fabricate to conform to floor slope so that standards and pedestals are plumb and chairs are maintained at same angular relationship to vertical throughout Project.

B. (Outdoor) Plastic backs shall have a smooth surface for easy cleaning and be constructed of double wall blow molded polyethylene with anti-static compound and ultra-violet light stabilizing additives. Backs shall have a nominal wall thickness of 0.125-inch 3mm and be ergonomically contoured for posture and sitting comfort.

C. (Outdoor) Plastic seats shall have a smooth surface for easy cleaning and be constructed of

double wall blow molded polyethylene plastic with anti-static compounds and ultra-violet light stabilizing additives. Seats shall have a nominal wall thickness of 0.125-inch 3mm and be ergonomically contoured for posture and sitting comfort.

D. Back height to be 32 inches 813mm from floor and extend below the seat to afford chair occupant protection from rear and eliminate any pinching hazard. Back length shall be 21 inches 533mm nominal.

E. Backs shall be recessed to receive an aluminum number plate. Label fitted in vandal resistant recess.

2.6 ACCESSORIES

A. Row Letter Plates: Row letters shall be a black letter etched on an elliptical aluminum plate. Letter plates shall be surface mounted to the aisle end stanchion.

B. Seat Number Labels: Black numbers silk screened on an adhesive backed elliptical lexan label. Labels fitted in a vandal resistant recess in the upper left-hand corner of the back.

C. Row Letter Labels: Black letters silk screened on an adhesive backed elliptical lexan label. Labels shall be surface mounted to the aisle end stanchion.

D. ADA Armless Stanchion: Armless stanchions shall be provided for at least 1% of the fixed seating capacity to meet the American with Disabilities Act (ADA). Each accessible chair shall include the universal handicap symbol on the end aisle stanchion for clear identification.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine floors, risers, and other adjacent work and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install seating in locations indicated and fasten to substrates according to manufacturer's written installation instructions.
   1. Install seating with each chair capable of complying with performance requirements without failure or other conditions that might impair the chair's usefulness.
   2. Install plumb.
   3. Install seating so moving components operate smoothly and quietly.

B. Install seating with end standards aligned or stepped as indicated from first to last row.

C. Install riser-mounted standards and attachments to maintain uniform chair heights above floor.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Inspect components, assemblies, and equipment, including connections, to verify proper, complete, and sturdy installation according to manufacturer's written instructions and product specifications.
   2. Verify that self-rising seats return to uniform at-rest, raised position.

B. Fixed audience seating will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust chair backs so that they are at required angles and aligned with each other in uniform rows.

B. Adjust hardware and moving parts to function smoothly so they operate easily. Lubricate bearings and sliding parts as recommended in writing by manufacturer.

C. Adjust self-rising seat mechanisms so seats in each row are aligned when in upright position.

D. Repair minor abrasions and imperfections in finishes with coating that matches factory-applied finish.

E. Replace damaged and malfunctioning components that cannot be acceptably repaired.

F. Replace upholstery fabric damaged during installation or work of other trades.

END OF SECTION 126100

SECTION 134900 - X-RAY PROTECTION

PART 1 GENERAL

1.1 SUMMARY

A. Work Results:

B. Principal Products:

1.2 SUBMITTALS

A. National Bureau of Standards: Comply with the requirements of the National Council on Radiation Protection and Measurement (NCRP) Report No. 49, "Structural Shielding Design and Evaluation for Medical Use of X-Rays and Gamma Rays of Energies up to 10 MeV", as applicable to this work.
   1. Comply with requirements of local regulatory agencies where local standards and criteria exceed the requirements of NCRP Report No. 49.

B. Single Source Responsibility:
   1. Provide radiation protection materials, equipment, and accessories produced as standard products of a single manufacturer regularly engaged in the production of X-ray shielding materials.

C. Product Data:
   1. Submit manufacturer's detailed technical product information and installation instructions for each item of x-ray protection and accessories required.

D. Shop Drawings:
   1. Submit shop drawings of the entire layout of the x-ray suite including special components and installations that are not fully dimensioned or detailed in manufacturer's product data. Show corners and all applications at ducts, conduits, misc. metals, and other penetrations.

1.3 DELIVERY, STORAGE AND HANDLING

A. Lead-Lined Hollow Metal Frames:
   1. Comply with requirements of Section 081113 for delivery, storage and handling requirements.

B. Lead-Lined Hollow Metal Doors:
   1. Comply with requirements of Section 081113 for delivery, storage and handling requirements.

C. Lead-Lined Gypsum Board and Plywood:
   1. Comply with requirements of Section 092900 for delivery, storage and handling

requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer:
1. Subject to compliance with requirements, provide products of one of the following:
a. A & L Lead Co., Inc.
b. Ameray Corp.
c. Bar-Ray Products, Inc.
d. Nelco (New England Lead Burning Co., Inc.) Nuclear Associates Radiation Protection Products, Inc.
e. Radiation Protection Products, Inc.

2.2 MATERIALS

A. Coordinate and Comply with the Industrial Radiography Technical Review Report provided by Carolina Safety & Health Consultants, LLC.

B. Lead Sheet shall be unpierced rolled virgin sheet lead conforming to requirements of FS QQ-L-201, Grade C, in sizes and thicknesses indicated on drawings.

C. Lead-lined gypsum board shall comply with requirements of ASTM C36 and FS SS-L-30, Grade 3, Type X, Class 1, Form a, Style 3. Provide gypsum board sheets not less than 1/2" thick, of width and length required for support spacing and to prevent cracking during handling. Laminate a single sheet of unpierced virgin lead sheet, thickness as indicated, to the back of gypsum board units. Provide 2" wide lead strips for lapping at joints.

D. Lead lined fire treated plywood shall comply with AWPA standards. Plywood must be exterior grade plywood with no urea formaldehyde.

E. Lead-Headed Nails: Provide lead-headed nails of size, type and design recommended by the system manufacturer.

F. Accessories and Fasteners: Provide the manufacturer's standard fasteners and accessories as required for the installation, maintaining equivalent protection as the system.

2.3 MANUFACTURED UNITS:

A. Lead-Lined Metal Door Frames:
1. Comply with requirements of Section 081113 for hollow metal frames.
2. Comply with Industrial Radiography Technical Review Report.
3. Provide additional reinforcements and internal supports to adequately carry the weight of lead-lined doors. Perform such work prior to installation of lead lining.
4. Line the inside of frames with a single thickness of unpierced sheet lead; sheet lead thickness shall not be less than the thickness of lead used in doors and walls in which the

frames are used. Form lead sheet to match the frame contour, continuous in each jamb and across the head, lapping the stops. Form lead shields around areas prepared to receive hardware. Fabricate lead lining wide enough to maintain an effective lap with the lead of adjoining shielding units.

B. Lead-Lined Doors:
   1. Comply with requirements of section 081113 for hollow metal doors.
   2. Comply with Industrial Radiography Technical Review Report.
   3. Fabricate doors of solid core flush construction with one or more continuous unpierced lead sheets to make up the total lead thickness indicated on the drawings. Apply lead sheet continuously from top to bottom and edge to edge. Lead lining may be constructed in the core, or between the core and cross-banding at the manufacturer's option. Assemble lead lining and banding at the manufacturer's option. Assemble lead lining and core with poured lead fasteners or steel bolts. Space lead dowels not more than 1-1/2" from door edge and approximately 8" on center. Countersink bolt heads and cover with poured lead.
   4. Shield cutouts for locksheets with sheet lead of the same thickness as used in the door; lap lead lining of locksets and the door lining.
   5. Steel sheet faces 1.6 mm (16 gauge) thick,[flush] design,[3 mm (1/8 inch)] and [6 mm (1/4 inch)] thick lead lining.
   6. Core: Reinforced steel.
   7. Top and Bottom Channels: Inverted, recessed, welded steel channels.
   8. Astragals: Lead-lined steel[T] shaped astragals for double doors.
   9. Lead-lined automatic door bottom.
   10. Fabricate doors with hardware reinforcement plates welded in place.

C. Control Windows:
   1. NOT USED.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where X-Ray Protection is to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 INSTALLATION

A. Lead Sheets in Concrete Slabs:
   1. NOT USED.

B. Lead-Lined Gypsum Board/Plywood:
   1. Comply with Industrial Radiography Technical Review Report.
   2. Install lead-lined gypsum board/plywood for walls and ceilings over supports as indicated.
   3. Refer to Section 092900 for suspended ceiling supports and metal stud supports.
   4. Predrill lead-lined gypsum board/plywood or drill pilot holes for fasteners.
   5. Provide a 2" wide strip of sheet lead of the same thickness applied to all metal supports

where joints in drywall panels occur.

6. Apply lead-lined drywall/plywood panels with long edges parallel to metal supports and lead lining facing supports. At end joints, provide 16 ga. steel wall plate spanning from support to support and covered with 2" wide strip of sheet lead.
7. Fasten drywall/plywood panels to steel support back up using fasteners and spacing as specified in Section 092900. Each fastener shall be covered with a lead disc equal in thickness to lead laminated to wallboard.
8. Apply a facing sheet of gypsum board/plywood over the lead lined base sheet using the manufacturer's recommended bonding adhesive. To ensure a positive bond maintain pressure on the finish panel until the adhesive has set.
9. Refer to Section 092900 for joint treatment and preparation for finishing.

C. Lead-Lined Hollow Metal Door Frames:
1. Comply with Industrial Radiography Technical Review Report.
2. Install frames following general standards specified in Section 06200 for metal frames in drywall assemblies and in accordance with lead shielding manufacturer's standards as required to maintain continuity of shielding.

D. Lead-Lined Doors:
1. Comply with Industrial Radiography Technical Review Report.
2. Refer to Section 062000 for installation requirements of hollow metal doors.
3. Finish hardware is specified in Section 087100 "Finish Hardware".
4. Hang doors to have a clearance of 1/16" at sides and top and with a minimum clearance at the bottom.

E. Built-In Items:
1. Comply with Industrial Radiography Technical Review Report.
2. Where other built-in items penetrate lead linings, provide lead shields as required to maintain continuity of shielding. Install shields in accordance with manufacturer's instructions.

F. Outlet Boxes, Ducts and Conduit:
1. Where outlet boxes, junction boxes, ducts, conduit and similar items (collectively called “MEP” interruptions) interrupt continuity of shielding, provide continuous shielding around the MEP interruptions in both directions perpendicular to the base shielding at least three times (3x) the larger dimension of the interruption (also see details).

G. Provide lead linings, sleeves, shields and other protection of an equivalent or greater thickness of lead as that used in the shielding system.

3.3 FIELD QUALITY CONTROL

A. Inspection:
1. When all shielding has been installed, but before it is covered, notify Owner, Owner retained radiation physicist, CM, and Architect to allow them to inspect the installation.

B. Testing:
1. After X-ray equipment has been installed and placed in operating condition, radiation shielding will be tested at the Owner's expense, by a radiation physicist, certified by a

nationally recognized agency.

2. Testing will be performed in accordance with requirements of NBS Handbook H-76 "Medical X-Ray Protection Up to Three Million Volts". The decision of the health physicist on acceptability shall be binding on the Contractor.
3. Repair or replace defective work, including other work affected thereby and conduct additional testing to the satisfaction of the health physicist, at no additional expense to the Owner, regardless of when the test results are made known.

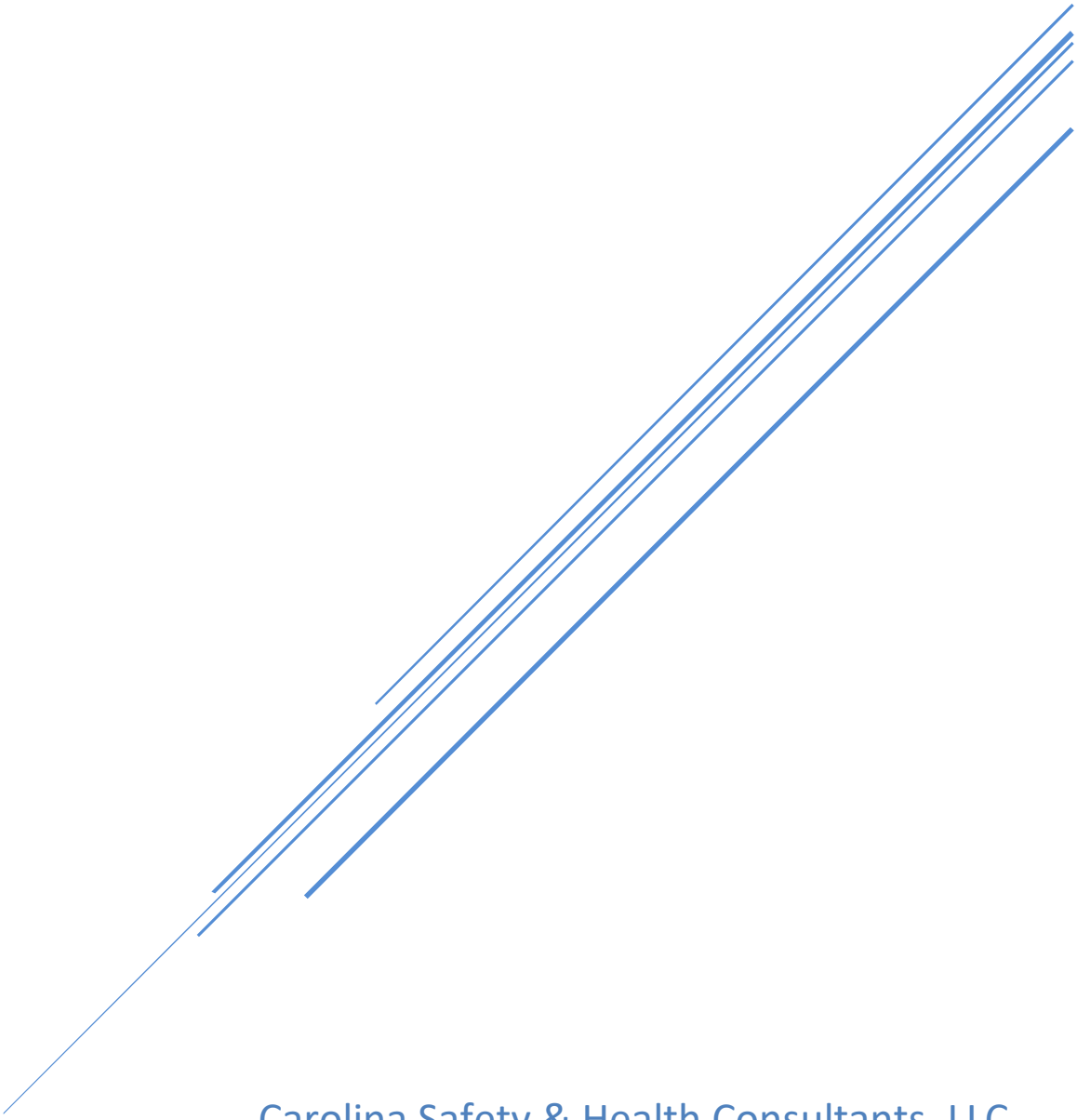
3.4 PROTECTION

A. Initiate and maintain protection of lead-linings throughout the remainder of the construction period, to ensure that the protective system will be free from damage at the time of Project completion.

END OF SECTION 134900

INDUSTRIAL RADIOGRAPHY TECHNICAL REVIEW REPORT

NC Museum of Art Conservatory
Radiography Vault Shielding Design and Operational Assessment



Carolina Safety & Health Consultants, LLC
Benjamin G. Midyette, Jr., MS, RSO, CHT, Senior Physicist

Carolina Safety & Health Consultants, LLC

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PHYSICIST QUALIFIED EXPERT CERTIFICATION

I, Benjamin G. Midyette, Jr., RSO, CHT, holding a Master's degree in Radiation Physics, and having substantial expertise in the field of radiation protection and regulatory affairs, hereby certify that I have conducted a thorough technical review of the industrial radiography operations and shielding design for the permanent radiography vault constructed for the NC Department of Natural and Cultural Resources, Museum of Art, Conservatory Department, located at 2110 Blue Ridge Road, Raleigh, NC 27607. This review has been conducted in compliance with the applicable federal regulations and industry standards.

This review assesses compliance with the North Carolina Administrative Code, Title 10A, Chapter 15 - Radiation Protection, specifically Sections .0100, .0200, .0500, .0800, .1000, and .1600, as well as the shielding design recommendations outlined in NCRP Report No. 49 as described in detail herein.

Key components of this evaluation included:

1. **Regulatory Compliance**: Verification that instructions have been provided to the registrant to ensure that all operations align with the definitions, registration requirements, regulatory requirements, standards for protection against radiation, precautionary procedures, inspections, and enforcement measures as mandated by the aforementioned sections.

2. **Shielding Design Evaluation**: A detailed assessment of shielding requirements for the proposed radiography vault was completed, based on NCRP Report No. 49 recommendations to ensure the integrity and adequacy of shielding within the radiography vault. This includes shielding material selection, barrier thickness calculations, and the layout configuration to provide optimal protection to radiographers and ancillary personnel and members of the public from ionizing radiation.

3. **Operational Safety Procedures**: Recommendations regarding the required safety protocols, emergency procedures, and staff training programs have been provided to the registrant to ensure adherence to regulatory requirements, industry best practices and effective radiation protection measures.

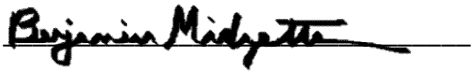
4. **Radiation Monitoring and Measurement Systems**: Recommendations for proposed radiation monitoring devices and equipment to ensure the required level of radiation safety for personnel. Recommendations were provided for the installation of interlocks, alarms, posting of warning signs, and other associated safety devices to meet the required specifications for accuracy, maintenance, and calibration in accordance with regulatory requirements and NCRP guidelines.

Based on my review, I conclude that the industrial radiography operations and shielding design of the vault will meet all of the state and federal regulatory and safety requirements detailed in this report. It is

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recommended that the registrant review the **Regulatory Compliance Section** at the end of this report to ensure comprehensive compliance with the applicable rules of the North Carolina Administrative Code 10A NCAC 15 under the regulatory authority of the North Carolina Department of Health and Human Services, Division of Health Services Regulation, Radiology Compliance Branch, Radiation Protection Section.

This certification is provided with the understanding that ongoing compliance with all regulatory requirements will be maintained if the recommendations of this report are followed, and any changes in operations or design will involve further review and possibly additional radiation surveys to ensure continued safety and compliance.



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February 15, 2025

Carolina Safety & Health Consultants, LLC

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Disclaimer Statement

Information in this Report was prepared and provided by Carolina Safety & Health Consultants, LLC to HH Architecture PA in connection with the technical review of the proposed industrial radiography operations including the radiography vault shielding design on behalf of the NC Department of Natural and Cultural Resources, NCMA East Building, 2110 Blue Ridge Road, Raleigh, NC 27607 for Project # 22-028.00, in compliance with North Carolina Administrative Code Title 10A, Chapter 15 - Radiation Protection, and the recommendations of NCRP Report No. 49.

The findings, opinions, and recommendations conveyed in this Report are based on the data and information provided by the client, HH Architecture PA, available at the time of review. While all reasonable care has been taken to ensure accuracy and compliance, the undersigned assumes no responsibility for errors or omissions, nor for any losses, damages, or liabilities that may arise directly or indirectly from reliance on information provided by the client, registrant, or their agents.

This certification provides professional advice regarding radiation protection including shielding design recommendations and regulatory compliance advise and recommendations and should not be relied upon as an architectural design document. It is recommended that the registrant facilities maintain continuous compliance with all applicable regulations and engage in regular consultations with legal and technical experts to address any changes in facility design, operational circumstances, or regulatory requirements.

This document is intended for use by the intended recipient and may contain privileged or confidential information. Unauthorized use, dissemination, or reliance on the information herein is strictly prohibited.

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INDUSTRIAL RADIOGRAPHAY TECHNICAL PLAN REVIEW

SHIELDING DESIGN & ASSESSMENT REPORT

Prepared For:

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Raleigh, NC 27609

On Behalf Of:
NC Department of Natural and Cultural Resources
NCMA East Building
2110 Blue Ridge Road, Raleigh, NC 27607

Re: HH Project # 22-028.00

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I. PURPOSE AND SCOPE OF THE REPORT

The following technical plan review and shielding design report was prepared by Carolina Safety & Health Consultants, LLC at the request of HH Architecture PA, for a proposed new permanent industrial radiography facility to be constructed for the NC Department of Natural and Cultural Resources, Museum of Art located at 2110 Blue Ridge Road, Raleigh, NC 27607.

The following report details the recommendations of the registered physicist qualified expert. This technical plan review and shielding design assessment was completed to meet the requirements of the North Carolina Administrative Code, Title 10A, Chapter 15 – Radiation Protection (NC Regulations for Protection Against Radiation), Sections 10A NCAC 15.0500 and 0800. Permanent radiographic installations and industrial radiography radiation generating devices (RGDs) are generally exempt from the requirements of the rules of Section .0800, except Rules 10A NCAC 15.0802 and .0804(a), (b)(1)(A), (b)(1)(C), (b)(2), and (b)(3) which are applicable to all radiation generating devices. Permanent radiographic installations and industrial radiography RGDs must comply with the applicable parts of the following Rules of Section .0500:

(1) .0501;

(2) .0502;

(3) .0506;

(4) .0509-.0520;

(5) .0522;

(6) .0523(a)(1);

(7) .0523(a)(3);

(8) .0523(a)(6) -.0523(a)(15);

(9) .0523(b)(1) -.0523(b)(4);

(10) .0523(b)(6) -.0523(b)(7);

(11) .0523(b)(9) -.0523(b)(12);

(12) .0523(c); and

(13) .0525.

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The structural shielding for the proposed radiography vault has been designed in accordance with the recommendations of **NCRP Report No. 49 - Structural Shielding Design and Evaluation For Medical Use of X-Rays and Gamma Rays of Energies Up To 10 MeV** to ensure compliance with the radiation dose limit requirements for each protective barrier as set forth in 10A NCAC 15, Section .1600, Rules .1604, .1609, .1610, .1611, and .1612.

II. EXECUTIVE SUMMARY

Section II of this Report includes an executive summary that provides an overview of the results of the radiography vault shielding design assessment and recommendations for the installation of protective barrier shielding for the radiography vault enclosure. Recommendations for installation of the Peltec X-ray system and associated safety devices, interlock and alarm systems required for safe operation of the radiography vaults and X-ray system.

Radiation Protection Program and regulatory compliance recommendations are also provided in this Report.

Introduction

This document presents a technical plans review and shielding design assessment for the installation and operation of the Peltec 2250 X-Series industrial X-ray system within the North Carolina Museum of Art Conservatory department. The implementation of this advanced X-ray system is aimed at enhancing non-destructive testing (NDT) processes for art and artifact conservation, ensuring that the integrity and authenticity of valuable pieces are preserved while allowing detailed examinations of their internal structures.

In alignment with the objectives of the Conservatory, it is imperative that the utilization of the Peltec 2250 X-Series conforms to the regulations set forth in the North Carolina Regulations for Protection Against Radiation, specifically 10A NCAC 15, Sections 0.500 and .0800. These regulations establish stringent requirements for radiation safety, shielding design, and operational protocols to protect both personnel and the public from unnecessary exposure to ionizing radiation.

This assessment will thoroughly evaluate the proposed shielding design, taking into consideration the operational parameters of the X-ray system, the architectural layout of the museum's Conservatory department, and the anticipated exposure scenarios. By adhering to established safety standards, this review aims to ensure compliance, mitigate radiation risks, and provide a safe environment for both staff and visitors while facilitating innovative conservation techniques. The ensuing sections will outline the shielding methodologies, calculations, and recommendations necessary for the effective implementation of the Peltec 2250 X-Series system within the museum's framework.

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Terminology Used In This Report

The term **shall** as used in this report indicates a recommendation that is necessary to meet the currently accepted North Carolina or corresponding NRC regulatory standards for radiation protection. The term **Should** indicates an advisory recommendation that is to be applied when practicable.

The term **agency** as used in this Report means the regulatory agency responsible for the regulation and enforcement of the North Carolina Administrative Code, Title 10A, Chapter 15 – Radiation Protection (NC Regulations for Protection Against Radiation), the NC Radiation Protection Section (NCRPS).

The term **Regulations** as used in this Report means the NC Regulations for Protection Against Radiation (10A NCAC 15).

Description of the Proposed Peltec 2250 X-Series X-ray System

The Peltec 2250 X-Series Industrial X-ray is a compact X-ray system designed for vault use for the NDT Industry. The Peltec 2250 X-Series industrial X-ray system offers advanced capabilities for NDT in a controlled environment. Its design emphasizes user safety, efficiency, and high-quality imaging, making it a valuable tool for industries requiring reliable material inspections.

The Peltec 2250 X-series Industrial X-ray compact system package was designed for vault use for the NDT industry. The unit is designed to produce 225 KV with a max output of 4000 watts. The Unit integrates a solid state power supply that is oil and gas free. The highly stabilized generating device produces a consistent 25 kHz X-ray output with low ripple/noise rate which delivers a more constant beam which produces high quality images using CR, DR, or Film/Screen based image receptor media.

The system also features an electric tube positional which allows the end-user to adjust the tube height to desired position. The adjustable tube is capable of achieving a maximum height of 104 inches down to 20 inches above the floor. The X-ray tube housing also has the capability to rotate the tube 180 degrees for angled radiographic projections.

The system can operate using a vertical or horizontal beam axis. Peltec X-series also incorporate a full compliance area alarm package that is required for vault operation. Peltec X-series also has a comprehensive fault diagnostic circuitry and Arc sense devices which protects the system from tube arcs.

X-ray System Technical Specifications

A technical description of the Peltec 2250 X-Series X-ray System highlighting its key features and specifications is provided below:

1. **X-Ray Source:** The 2250 X-Series X-ray system is designed to produce 225 kVp at a maximum tube current of 30 mA and a maximum power output of 4000 watts, with a high frequency generator that is able to produce a consistent 25 kHz output with low ripple/noise rate delivering a more constant

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primary X-ray beam that produces a better image. The X-ray system includes a dual focal spot (small and large), selectable via interface signal.

Type: Industrial high frequency X-ray tube and generator capable of generating high-quality, penetrating X-rays.

Output: Typically operates in kVp ranges (e.g., 160-225 kV) suitable for examining various materials, including metals and composites.

Filtration: Designed to optimize beam quality and reduce scatter.

2. **Detector Systems:** Peltec 2250 X-Series industrial X-ray system is compatible with CR, DR and film based image receptors.

   Digital Detectors: Utilizes flat-panel detectors or image intensifier systems to capture images quickly and with high resolution.

   Image Quality: Ensures high fidelity in imaging with advanced sensitivity and contrast capabilities.

   Integration: Compatible with software for real-time image processing and analysis.

3. **Control System:** The system can be operated through a control interface that can be operated with a hardware controller or remotely via computer ethernet interface utilizing a VB GUI.

   User Interface: Equipped with an intuitive control panel or touchscreen that allows for easy setup and operation.

   Positioning Controls: The Peltec 2250 system also features an electronic X-ray tube positioning device which allows the end-user to adjust the X-ray tube height to a desired position. The adjustable tube stand is capable of achieving a maximum height of 104 inches down to 16 inches. The system can operate in a vertical or horizontal beam direction whereas the X-ray tube hosing and collimator can rotate the tube 180 degrees for angular radiographs.

   Automation: Capable of automated exposure controls and settings for consistent results.

   X-ray System Dimensions: Compact design optimized for space within a radiography vault.

   Weight: Designed for stability with robust construction materials.

   Power Supply: Requires a stable electrical supply, typically 3-phase, for high-output operations. The Peltec X-series also has comprehensive electrical fault diagnostic circuitry and arc sense devices which protects the system from X-ray tube arcs.

   Cooling System: Features ventilation or cooling mechanisms to manage heat generated during operation. The Peltec X-series utilizes an external chiller system for cooling the coolant in X-ray tube. The chiller system features quick lock connectors.

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Applications: The Peltec 2250 X-Series system is ideally suited for a range of NDT applications, including:

- Weld of other joint inspections
- Casting examinations of artifacts
- Evaluation of artifact structural integrity
- Analysis of artifact components and internal features



Figure 1. Peltec 2250 X-Series Industrial X-ray System

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III. DESCRIPTION OF RADIOGRAPHIC WORK PROCESSES

The proposed X-ray generating equipment will be operated in the Conservation facilities of the North Carolina Museum of Art (NCMA). The NCMA is building new Conservation facilities that are scheduled to be completed by December 2026. Construction will include renovation of the existing ground level conservation studio, which will include a new X-ray examination room as detailed in **Appendix A**.

The Peltec 2250 X-series industrial X-ray system as described herein will be used in the future Conservation facilities on the ground floor of the East building of the NCMA. This equipment will be used intermittently to analyze artwork, on average about 12 times per year or approximately once per month. The artwork that may be radiographed as part of the NCMA conservation efforts include paintings, sculptures, and pieces of furniture and other decorative arts objects including Egyptian funerary art, sculpture and vase painting from ancient Greece and Rome, and American art of the 18th through 20th centuries.

The proposed X-ray equipment to be used in the new facility will be the Peltec 2250 X-series, which is designed to produce 225 kV. Note that in addition to the specifications below, an additional five foot extension will be added to the tube holder. This extension will facilitate shooting down without the interference of the X-ray equipment's legs. The Peltec 2250 X-series is a cart system. The cart with tube should be able move throughout the examination room.

In addition, the X-ray tube housing and collimator is attached to the end of a boom that can be raised and lowered, allowing the tube to goes as high as 104 inches and close to the floor. The X-ray tube can be turned 180 degrees (portrait vs landscape) and rotated to adjust the angle of the X-ray beam. The X-ray system will be used to perform radiography of artwork in the downward position approximately 80% of the time where the primary X-ray beam will be directed towards the floor (U = 0.80) and directed toward the north wall of the radiography vault (U = 0.20) the remaining 20% of the time. See the site drawing in **Appendix B** for details of the X-ray system installation and constraints on movement within the vault.

The X-ray equipment workload is expected to vary throughout the year and will likely be used more frequently over a few consecutive weeks throughout the year; and then not at all for a month or more. When not in use for an extended period, the X-ray system will be deenergized with the exception of being operated for the purpose X-ray tube curing and warmup cycle as part of its regular maintenance (once per month as necessary). The estimated X-ray system "ON" time is expected to average about 30 minutes per week when in regular operation.

The expected maximum weekly normalized radiological workload $\boldsymbol{W_N}$ will be approximately 900 mA-minutes per week at an expected X-ray tube potential range between 60 kVp - 225 kVp). The radiographic technical factors utilized for the proposed X-ray system may include the use of film/screen,

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computed radiography (CR) digital radiographic (DR) equipment and associated techniques. Assuming the most utilized technical factors will have X-ray tube potentials in the range of 30 – 225 kVp and tube current in the range of 5 – 30 mA, exposure times may range from 0.1 – 0.5 seconds.

The technical factors may be varied within these ranges for specific types of artwork and imaging techniques used (film/screen, CR or DR). Exposure time for some types of artwork depending upon composition and density may range from 0.5 – 10 seconds. But higher exposure times are likely to be infrequent. The range of typical technical factors that may be used for the X-ray system for diverse materials and structures of the artworks is provided below based on the expected type of artwork to be radiographed:

1. **Paintings (Canvas and Wood)**

   Tube Potential (kVp): 30 - 50 kVp for canvas; slightly higher for wood[1].

   Tube Current (mA): 5 - 10 mA.

   Exposure Time: 0.5 - 2 seconds, adjust based on the thickness and density of the painting.

2. **Vases (Ceramic)**

   Tube Potential (kVp): 60 - 100 kVp.

   Tube Current (mA): 10 - 20 mA.

   Exposure Time: 1 - 3 seconds, based on the ceramic's thickness and glaze.

3. **Statuary (Metallic, Stone)**

   Tube Potential (kVp): 100 - 225 kVp.

   Tube Current (mA): 20 - 30 mA.

   Exposure Time: 2 - 5 seconds, with longer exposure times needed for denser materials.

4. **General Considerations**

   Image Receptors: Both Computed Radiography (CR) and Digital Radiography (DR) are suitable. DR offers faster processing and higher image quality.

   Generator Frequency: A high-frequency generator (25 kHz) ensures consistent and high-quality X-ray output and high quality high definition imaging capacity.

Typical artwork radiographed is expected to be paintings on canvas, sculptures in metals, stone and other materials, and ceramic artwork as shown below.

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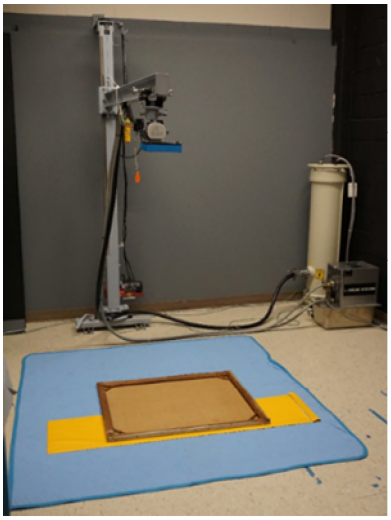




Figure 2. Examples of Conservation Radiographic Procedures

Radiography Vault Shielding Design Requirements

The shielding design requirements for the proposed radiography vault were determined using the protective barrier shielding calculations and other reference materials recommendations of the **National Council On Radiation Protection And Measurements (NCRP)** in **Report No. 49 - Structural Shielding Design and Evaluation for Medical Use of X Rays and Gamma Rays of Energies up to 10 MeV**, **Report No. 147** - **Structural Shielding Design for Medical X-Ray Imaging Facilities,** and **Report No. 151 - Structural Shielding Design and Evaluation for Megavoltage X-and Gamma-ray Radiotherapy Facilities**.

Radiography Vault Specifications

The proposed Peltec X-ray system must be operated within a permanent industrial radiography vault enclosure that meets the requirements of the North Carolina Regulations for Protection Against Radiation, Rule 10A NCAC 15.0807. The proposed radiography vault enclosure must be designed with adequate lead equivalent shielding capacity (LESC) to ensure compliance with the occupational dose limit requirements of Rule 10A NCAC 15.1604 and the member of the public unrestricted area requirements of Rule 10A NCAC 15.1611(a).

The vault enclosure protective barrier shielding materials considered here include additional lead shielding installed onto existing wall construction, steel door and frame or an appropriate combination of these for the enclosing protective barrier shielding having sufficient LESC values to ensure radiation exposures that are ALARA for all staff personnel operating the equipment and other individual members of the public that may be present in unrestricted areas adjacent to the radiography vault.

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Vault Enclosure Protective Barrier Shielding Requirements

The radiography vault enclosure is required to be constructed with primary and secondary protective barriers. Two primary and six secondary protective barriers are described in this Report. The two primary protective barriers are the north wall of the radiography vault designated as wall section **FG** and the floor as depicted in the site drawing in **Appendix B** of this Report. The six secondary protective barriers are the enclosing walls (**AB, BE, EF,GA**), access door (**CD**) and the vault roof.

The base construction of the existing enclosing primary and secondary barriers of the radiography vault enclosure are referred to in this Report as pre-shielding construction. Pre-shielding construction refers to the lead equivalent shielding capacity of the existing construction. Pre-shielding construction has not been considered in the calculations for the **primary** or **secondary** protective barrier shielding. Therefore, the only shielding consideration is this case is the thickness of lead or equivalent materials added to existing construction that is required to attenuate the primary X-ray beam and secondary radiation fields to unrestricted area radiation field intensities (< 2 mrem/h) at a reference point 30 cm beyond the protective barrier adjacent to the area protected.

Primary Protective Barrier Shielding

Wall FG

Radiological Conditions: (P = 0.02 Gy/wk., T = 1, U = 0.20, W_T = 900 mA-min/wk.)

The primary protective barrier shielding for wall FG should be composed of minimum nominal lead thickness of 19.5 mm laminated to ¾ inch to 1 inch plywood to be installed over existing wall construction. The lead sheet should cover the wall from the floor to the vault roof slab. I have enclosed lead sheet product specification at the end of this Report for your review.

Vaults Floor Slab

Radiological Conditions: (P = 0.02 Gy/wk., T = 0, U = 0.80, W_T = 900 mA-min/wk.)

Since there is no occupiable space below the floor slab existing construction is sufficient for the X-ray vault floor and no additional shielding is needed.

Secondary Protective Barrier Shielding

A. Enclosing Walls

The secondary barrier walls (**AB, BE, EF,GA**) also have pre-shielding existing construction. As was the case for the primary protective barriers, pre-shielding construction lead equivalent shielding capacity is not considered in the secondary protective barrier calculations. The secondary barrier shielding calculations indicate that **minimum nominal lead thickness of 6 mm of lead laminated to ¾ inch to 1 inch plywood to be** installed to **cover the wall from the floor to the vault roof slab.**

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B. Vault Access Door

The vault access door must be constructed of materials that provide equivalent shielding capacity as that required for the secondary protective barrier wall **BE** as shown in the site drawing in **Appendix B** of this Report. Two types of door systems are recommended for the radiography vault access door. A sliding door may be installed for the radiography vault entry similar those shown below but without a window installed. The recommended sliding doors have the advantage of completely covering the door opening with no gaps that would need to be sealed around the door opening.



Figure 3. Railed Motorized Sliding Shielded Door

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Figure 4. Manually Operated Sliding Shielded Door

Additionally, a more traditional type hinged door may also be installed for the radiography vault entry as shown below.



Figure 5. Traditional Solid Core Wood Door (Lead Core)

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Lead Lined Door Specifications

The lead equivalent shielding capacity (LESC) for secondary radiation fields at the access door must be at least that of the wall in which it is installed. Therefore, the vault access door should have the same or greater LESC value (**6 mm lead**) to ensure compliance with requirements of the NC Administrative Code – Rule 10A NCAC 15.1611(a). The door frame and hardware must have the same equivalent shielding capacity as the door (**6 mm LESC**)

The radiography vault access door may be of a hinged or sliding type door. There are a number of options available. Specifications provided below should be considered for the shielded access door:

1. **Material**:

   Core: Solid core wood or hollow metal filled with lead.

   Lead Thickness: Equivalent to 6 cm of lead, which can be achieved by using multiple layers of lead sheeting.

2. **Construction**:

   Lead Lining: The door should be lined internally with lead sheets that cover the full height and width of the door.

   Frame: Lead-lined hollow metal frames constructed with 16 or 18 gauge steel, lined with sheet lead to match the door's lead thickness.

3. **Dimensions**:

   Thickness: The door should be thick enough (1.75 in. or greater) to accommodate the required lead lining while maintaining structural integrity.

   Size: The door is customizable to fit the specific dimensions of the vault entry.

4. **Hardware**:

   Hinges: Heavy-duty continuous hinges to support the weight of the lead-lined door.

   Heavy Duty Motorized Rail System: A motorized rail system to accommodate a sliding access door.

   Locks: Lead-lined locksets to ensure no radiation leakage through the locking mechanism.

   Seals: Lead-lined door sweeps and shielded thresholds to minimize gaps and prevent radiation leakage.

5. **Additional Features**:

   Automation: Motorized options for ease of use, especially for heavy doors. Shielded doors can weigh 500 lbs. or more.

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Fire Rating: Fire-rated options available if required.

To ensure that either of the doors proposed possess the appropriate lead equivalent shielding capacity the door should be purchased from a vendor that specializes in doors designed for radiation shielding. Our preferred vendor for this is MarShield. I have enclosed a door spec sheet at the end of this Report for your review.

Vault Roof Shielding Requirements

The radiography vault roof should be constructed similarly to that of the walls. The lead equivalent shielding capacity (LESC) of the existing concrete and steel decking was considered pre-shielding and ignored in the of the shielding design. The vault roof construction should possess a minimum lead equivalent shielding capacity of **6 mm of lead** to ensure the required shielding capacity is achieved. The secondary barrier shielding calculations indicate that **minimum nominal lead thickness of 6 mm of lead laminated to ¾ inch to 1 inch plywood to be** installed to **cover the vault roof slab from wall to wall.**

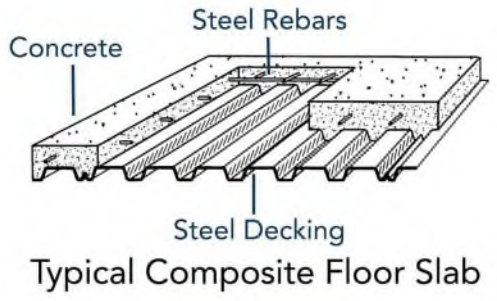


Figure 6. Vault Roof Design

Vault Security and Access Controls

Security

Vault access controls must be in accordance with the security provisions of Rules 10A NCAC 15.0514, and 10A NCAC 15.1622, such that during radiographic operations the radiographer or radiographer's assistant shall maintain a continuous direct surveillance of the operation to protect against unauthorized entry into the High Radiation Area inside the vault, as defined in **Definitions** section of this Report, except where the High Radiation Area is equipped with a control device or an alarm system as described in Rule 10A NCAC 15.1615 or is locked from the outside to protect against unauthorized or accidental The registrant shall secure the X-ray system while installed in the radiography vault in accordance with the provisions of Rule 10A NCAC 15.1622. The X-ray system shall be secured from removal or unauthorized access including the controlled area of the operator control room and the restricted area of the radiography vault enclosure. The registrant shall control access to the radiography vault and X-ray

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controls, and maintain constant surveillance of the X-ray system and radiography vault when the X-ray system is in operation and when idle or in storage.

Vault Access Controls

Safety devices must be installed in the radiography vault that are in accordance with the provisions of 10A NCAC 15.1615 – Control of High Radiation Areas. The registrant shall ensure that each entrance or access point to a **High Radiation Area** has at least one of the following safety devices is installed.

(1) A control device that, upon entry into the radiography vault, causes the level of radiation to be terminated or reduced below that level at which an individual might receive a deep-dose equivalent of 0.1 rem (1 mSv) in one hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates; or

(2) A control device that energizes a conspicuous visible or audible alarm signal so that the individual entering the **High Radiation Area** and the supervisor of the activity are made aware of the entry; or

(3) Entryways that are locked, except during periods when access to the areas is required for the purpose of radiological operations, with positive control over each individual entry. It is recommended that if this method of controlling access to the radiography vault during radiographic operations is utilized, that the door locking mechanism be designed in accordance with the requirements of OSHA 29 CFR § 1910.36(d)(1) - Employees must be able to open an exit route door from the inside at all times without keys, tools, or special knowledge. A device such as a “fail-safe” panic bar that locks only from the outside is permitted on exit discharge doors.

Required Vault Safety Devices and Interlocks

Radiography vaults having High Radiation Areas, must have the following safety devices and interlocks installed to ensure the safety of personnel and compliance with the applicable regulations of the NC Administrative Code, .0500, .0800, .1000 and .1600:

A. Radiation Monitors and Alarms: Radiation monitoring devices shall be installed within the vault enclosure that ensure compliance with the provisions of Rule 10A NCAC 15.1615. These devices continuously monitor radiation levels and trigger alarms if levels exceed preset thresholds. For a radiography vault using a 225 kVp, 30 mA X-ray system that is likely to produce radiation fields in excess of 100 mR/h at one meter, an area radiation monitor must be installed that is capable of detecting and measuring ionizing radiation levels above 5 mR/h accurately and providing real-time monitoring.

The Peltec X-series X-ray system incorporates an area alarm package that is required for vault operation in accordance with **10A NCAC 15.1615 - Control Of Access To High Radiation Areas**. Another example of such a system is the Thermo Scientific Area Radiation Monitoring System, which includes features like real-time updates, remote monitoring, and configurable alarm set points. Key features of the required area radiation monitor to consider are provide below:

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- **High Sensitivity**: The area radiation monitor should be sensitive enough to detect low levels of radiation from 5 mR/h to 500 mR/h to ensure early warning of dangerous radiation fields in the vault.
- **Real-Time Monitoring**: The area radiation monitor should provide continuous, real-time monitoring of radiation levels.
- **Alarm System**: The area radiation monitor should have audible and visual alarms to alert personnel immediately if radiation levels exceed preset thresholds.
- **Data Logging**: The area radiation monitor should have the capability to log data for regulatory compliance and recordkeeping.
- **Remote Monitoring**: The area radiation monitor system should support remote monitoring and control, allowing for oversight from a safe distance in the X-ray control room area.

B. Warning Systems: Warning systems that include audible and visible warning signals and warning signs must be installed within and at the entrance of the radiography vault to ensure adequate warnings of potential radiation exposure. The following warning systems are required:

a. Clearly visible warning lights and signs must be installed on the exterior of the vault enclosure and near the vault access door to indicate when the X-ray equipment is in use.

b. Audible and visible warning signals shall be installed within the vault enclosure which are actuated for at least 10 seconds immediately prior to the first initiation of X-ray generation after closing the access door . Failure of any single component of the X-ray system, safety devices or interlocks shall not cause failure of both the audible and visible warning signals.

c. Warning signs shall be conspicuously posted in accordance with the requirements of Rule 10A NCAC 15.1623, bearing the radiation caution symbol and the words "**Caution (or Danger) – High Radiation Area"** or words having similar meaning at the entrance of the vault where radiation levels may exceed 100 mR/hr. Additional warning signs with the words "**Keep Out & Radiography in Progress"** is recommended to enhance restricted area control and ensure that unauthorized personnel do not enter the area during radiography operations.

C. Interlock Systems: Electronic interlocks must be installed on the vault access door that automatically terminate the X-ray beam if the vault door is opened during operation or prevent the X-ray system from activating the X-ray beam if the door is not properly closed during operations. The access door to the vault shall have a minimum of two safety interlocks. One, but not both of the required interlocks shall be such that door opening results in physical disconnection of the energy supply circuit to the high-voltage X-ray generator, and such disconnection shall not be dependent

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upon any moving part other than the door. Following interruption of X-ray generation by the functioning of any safety interlock, use of a control provided by the X-ray system manufacturer shall be necessary for resumption of X-ray generation.

D. Emergency Stop Buttons: Easily accessible emergency stop buttons should be installed at the control panel to immediately shut down the X-ray equipment in case of an emergency.

E. X-ray System Controls Lockout: A key-actuated control must be installed at the X-ray system control panel to ensure that X-ray generation is not possible with the key removed. If X-ray system controls are actuated through a PC workstation GUI the key actuated controls may be replaced by a password used to unlock the PC workstation controls.

Posting of Radiation Warning Signs

The radiation field intensity inside the radiography vault is estimated to range from approximately 100 - 3375 mR/h based on the radiographic procedures performed. Therefore, the radiography vault is classified as a **High Radiation Area**. Warning signs with the words **Caution (or Danger) – High Radiation Area** are required for areas where radiation levels exceed 100 mR/hr. Adding these warnings to the signs with the words **Keep Out & Radiography in Progress** is recommended to enhance area control and ensure that unauthorized personnel do not enter the area during radiography operations.

X-ray System Installation Requirements

The local components of the proposed Peltec 2250 X-series X-ray system shall be located and arranged in accordance with the recommendation of this report and include sufficient lead equivalent protective barrier shielding and access control to ensure no radiation fields exist in any area surrounding the local components or within 30 cm from any accessible exterior surface of the vault's protective enclosure that could result in a dose to an individual present in excess of the dose limits given in Rule 10A NCAC 15.1611(a). The registrant shall conduct radiological operations such that the total effective dose equivalent to individual members of the public from the registered radiography operation does not exceed 0.1 rem (100 mrem) in a year exclusive of the dose contribution from natural background radiation; and the dose in any unrestricted area from external sources of ionizing does not exceed 0.002 rem (2 mrem) in any one hour as a time weighted average (TWA) over an 8-hour period. If the registrant permits members of the public to have access to controlled areas such as the Microscopy Room, the limits for members of the public continue to apply to those individuals. Since the Microscopy Room has been designated as the operator control room for radiography operations the controlling shielding design goal (***P***) shall be those assigned to members of the public in unrestricted areas.

The proposed X-ray system shall be installed such that the primary X-ray beam is restricted to the designated primary protective barrier (**wall section FG**). Restricting the primary X-ray beam orientation will limit the area requiring primary protective barriers to that which can be struck by the useful

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collimated X-ray beam plus a suitable safety margin which shall be a minimum of 1 foot (30 cm) beyond the edge of the image receptor. The X-ray source to image receptor distance along the axis of the primary X-ray beam may be varied such that at maximum collimation the collimated primary X-ray beam shall be limited to the area of interest or the image receptor, whichever is smaller.

Means shall be provided for visually defining the perimeter of the X-ray field. The total misalignment of the edges of the visually defined field with the respective edges of the X-ray field along either the length or width of the visually defined field shall not exceed two percent of the distance from the source to the center of the visually defined field when the surface upon which it appears is perpendicular to the axis of the X-ray beam.

III. PROTECTIVE BARRIER SHIELDING DESIGN AND ASSESSMENT

The shielding design for the facility described herein is based on the recommendation of **NCRP Report No. 49 - Structural Shielding Design and Evaluation for Medical Use of X Rays and Gamma Rays of Energies up to 10 MeV, NCRP Report No. 147** - **Structural Shielding Design for Medical X-Ray Imaging Facilities** and **NCRP report No. 151 - Structural Shielding Design and Evaluation for Megavoltage X-and Gamma-ray Radiotherapy Facilities**. This Report focuses primarily on the structural shielding design and evaluation for orthovoltage X-ray systems (200 - 500 kVp) as described in Appendix C of NCRP Report No. 49.

A. Radiography Vault Description

The proposed X-ray system is capable of operating at X-ray tube potentials up to 225 kVp at tube currents as high as 30 mA. Therefore, the radiography vault as described herein is classified for the purpose of radiation protection to be an orthovoltage radiography facility. The term “orthovoltage" is used to describe radiography using electronically generated X rays produced at X-ray tube potentials ranging from 200 to 500 kVp. Orthovoltage radiography vaults must be constructed to include primary and secondary protective barriers in accordance with the applicable requirements of NCRP Report No. 49, Section 6. In addition, the radiography vault must be constructed to meet the 10A NCAC 15, Section .0500 and .0800 requirements for enclosed X-ray systems and permanent radiography installations such that the proposed X-ray system is completely enclosed such that all possible primary X-ray beam paths and secondary radiation sources are contained within the interior of the enclosure to prevent any part of the body from intercepting the beam during normal operations.

Normal access to the primary X-ray beam path and secondary radiation sources , such as a radiography vault access door, shall be interlocked with the high voltage of the X-ray tube or high voltage generator Since the proposed X-ray system is inherently an open-beam device placed in an interlocked enclosure, it is considered as an "enclosed beam" device in accordance as defined in 10A NCAC 15.0802(11) unless there are provisions for routine bypassing of the required interlocks. The access door to the radiography

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vault must have fail-safe characteristics. "Fail-safe characteristics" means a design feature that causes the primary X-ray beam to terminate upon opening the vault access door, the failure of a safety or warning device such as an "X-ray On" light indicator, alarm system, shutter indicator or interlock failure.

The walls of the radiography vault must be design and constructed to ensure that the dose limit requirements in the provisions of Rules 10A NCAC 15.1604 and .1611(a) for occupational exposure and member of the public exposures to ionizing radiation fields respectively. Structural shielding shall be provided to ensure compliance with Rules 10A NCAC 15.1604 and .1611(a) of the North Carolina Administrative Code.

The vault access door must be designed such that it has at a minimum, the same or greater lead equivalent shielding capacity as that of the wall in which it is installed. In addition, the vault access door must be interlocked in accordance with the provisions of **10A NCAC 15.1615 - Control Of Access To High Radiation Areas** which requires registrants of permanent radiography facilities to ensure that each entrance or access point to a **High Radiation Area** has at least one of the following features:

(1) A control device that, upon entry into the area, causes the intensity of the radiation field inside the radiography vault to be reduced below that level at which an individual might receive a deep-dose equivalent of 0.1 rem (1 mSv) in one hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates; terminates the radiation source entirely.

(2) A control device that energizes a conspicuous visible or audible alarm signal so that the individual entering the **High Radiation Area** and the supervisor of the activity are made aware of the entry.

(3) Entryways that are locked, except during periods when access to the areas is required, with positive control over each individual entry.

In place of the controls required by 10A NCAC 15.1615(a) for a **High Radiation Area**, the registrant may substitute continuous direct or electronic surveillance that is capable of preventing unauthorized entry into the **High Radiation Area**.

“High Radiation Area" means an area, accessible to individuals, in which radiation field intensity from ionizing radiation sources external to the body could result in an individual receiving a dose equivalent in excess of 0.1 rem (1 mSv) in one hour at 30 centimeters from the radiation source or from any surface enclosing the source that the radiation penetrates.

Description of Radiography Vault Enclosing Protective Barriers

The radiography vault enclosure is composed of existing wall construction consisting of concrete masonry units (CMUs), steel studs, insulation, and type X gypsum wallboard. These structures are not considered in the calculation of the primary and secondary protective barriers.

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Primary Protective Barriers

The primary protective barrier is that barrier that is struck by the collimated primary X-ray beam and is normally designated as being perpendicular to the axis of the primary X-ray beam as it leaves the X-ray tube collimator and intercepts the target and barrier at a ninety-degree angle relative to the surface of the barrier. In the design of primary protective barriers, due consideration **should** be given to possible future changes in techniques which may increase the use factor (U) or occupancy of adjacent areas. The designated primary protective barrier as described herein is **wall section FG** and the floor as shown in the site drawing in **Appendix B**.

Secondary Protective Barriers

Secondary protective barriers considered in this report are those barriers that are intercepted only by secondary X-ray radiation fields. Secondary radiation fields are composed of first and second scattered radiation fields and leakage radiation from the X-ray tube protective housing. Radiation fields scattered from the target, image receptor and other first scattering surfaces struck be the primary X-ray beam, secondary backscattered radiation resulting in sky shine and leakage radiation emitted by the energized X-ray tube are considered as sources of secondary radiation fields in the shielding design of the enclosing protective barriers.

All enclosing protective barriers that are adjacent to occupied areas shall be in accordance with the ALARA provisions of Rule 10A NCAC 15.1603(b). The registrant shall use administrative procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are as low as is reasonably achievable (ALARA). All enclosing protective barriers are classified as secondary protective barriers except **wall section FG** and the **floor** which are classified as primary protective barriers. **Wall section FG** and the **floor** have been assigned use factors (U_w = 0.20) and (U_f = 0.80) respectively. All primary and secondary protective barriers are identified and described in **Table 1** and **Appendix B.**

Computation of Protective Barrier Shielding Requirements

Primary protective barrier shielding requirements for the radiography vault account for the direct collimated primary X-ray beam emissions from the X-ray tube and focused on the radiographic target. The primary protective barrier is designed to attenuate and absorb the directed energy of the portion of the primary X-ray beam that is transmitted through the target material and image receptor and into the primary barrier wall.

Secondary protective barrier shielding requirements for the radiography vault additionally, must account for all secondary radiation sources within the vault. Secondary radiation sources include radiation fields resulting from Primary X-ray beam radiation scattered from the target, image receptor and primary barrier wall, leakage radiation and sky shine radiation fields. The shielding requirements for primary and secondary protective barrier will be addressed in this section of the Report.

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All wall, and floor areas exposed to the useful collimated primary X-ray beam shall have primary protective barriers of sufficient lead equivalent shielding capacity (LESC) to attenuate the radiation field intensity to levels at or below the regulatory dose limits for the adjacent areas at a reference point 30 cm from the surface of the barrier. Primary protective barriers in walls shall extend to a minimum height of 84 inches above the finished floor.

Secondary protective barriers shall be present in the enclosing walls, floor and ceiling areas not having a primary protective barrier or where the primary barrier requirements are lower than the secondary barrier requirements. Secondary protective barriers shall be constructed of sufficient lead equivalent shielding capacity (LESC) materials to attenuate all secondary radiation field intensities to levels at or below the regulatory dose limits for the adjacent areas at a reference point 30 cm from the surface of the barrier.

When a mobile X-ray system is operated inside the radiography vault, the system shall be installed as a stationary unit. The primary X-ray beam shall be restricted to the designated primary protective barriers. The designated primary barriers for the radiography vault are the north wall of the vault (wall section FG) and the vault floor. The mobile X-ray system and all local components that emit radiation fields whether intentionally directed or incidental to the operation of the system shall be centrally located and arranged within the radiography vault such that all enclosing secondary protective barriers include sufficient shielding capacity and access control to ensure no radiation fields exist in any area surrounding the radiography vault enclosure that could result in a radiation dose to an individual member of the public present in excess of the dose limits given in Rule 10A NCAC 15.1611(a).

Operator's Control Station

The radiography vault operator's control station shall be in a separate room in a protected area which will intercept the secondary (scattered, leakage, sky shine) radiation fields from the radiographic target, image receptor and enclosing walls, ceiling and floor of the radiography vault. The operator control room wall adjacent to the radiography vault shall be provided with secondary protective barrier shielding. A window of lead-equivalent glass equal to that required by the adjacent barrier or a video surveillance system shall be provided to ensure that the operator is able to see all areas of the radiography vault without having to leave the protected area during radiography.

Shielded Protective Barrier Radiation Protection Design Goals

In this report, shielding design goals (P) are levels of ionizing radiation dose equivalent (**H**) used in the design calculations and evaluation of the enclosing protective barriers constructed for the protection of occupationally exposed radiation workers operating or working around the X-ray system or members of the public in unrestricted areas. **Occupational** exposure means exposure of an individual to ionizing radiation in the course of employment in which the individual's normal duties or authorized activities necessarily involve the likelihood of exposure to ionizing radiation. **Member of the public** means any

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individual except when that individual meets the definition above for occupational exposure and is receiving an occupational dose.

Shielding design goals (***P***) are practical values, for the radiation field intensity a single industrial radiography ionizing radiation (photon) source or set of sources, which are evaluated at a reference point 30 cm beyond an enclosing protective barrier. When used in conjunction with the conservatively safe technical factors and shielding design assumptions in this Report, the shielding design goals will ensure that the respective annual values for (**E**) recommended in **NCRP Report No. 147** - **Structural Shielding Design for Medical X-Ray Imaging Facilities** (NCRP, 2004). In this Report, *shielding design goals* (*P)* are levels of air kerma used in the design calculations and evaluation of barriers constructed for the protection of employees and members of the public. There are different shielding design goals for controlled and uncontrolled areas due to the regulatory dose limits of 10A NCAC 15.1604 and .1611(a) for occupational and member of the public radiation doses. The following are the recommended shielding design goals for occupationally exposed radiation workers and members of the public.

The weekly shielding design goals (***P***) recommended by **NCRP Report No. 49 - Structural Shielding Design and Evaluation for Medical Use of X Rays and Gamma Rays of Energies up to 10 MeV**, for controlled areas, (P_c) (occupational exposure limits) is an air-kerma value of 100 mrem/wk. The weekly shielding design goal (P_u) for an uncontrolled area (non-occupationally exposed members of the public) is an air-kerma value of 2 mrem/wk.

Occupational Dose Limits: (Controlled / Restricted Areas) – P_c = 0.1 mGy/wk. (5 mSv/y)

Member of the Public Dose Limits: (Unrestricted Areas) - P_u = 0.02 mGy/wk. (1 mSv/y)

The recommended radiation protection quantity for the limitation of exposure to individuals from sources of ionizing radiation is effective dose (E), defined as the sum of the weighted equivalent doses to specific organs or tissues (i.e., each equivalent dose is weighted by the corresponding tissue weighting factor for the organ or tissue) (NCRP, 1993). The effective dose equivalent (H_E) is the sum of the products of the dose equivalent to the organ or tissue (H_T) and the weighting factors (w_T) applicable to each of the body organs or tissues that are irradiated ($H_E = \Sigma w_T H_T$).

Some of the physical factors used in determining the barrier requirements for the referenced X-ray beam source are shown in **Figure 7** below. The X-ray tube source at **A**, surrounded by its protective tube housing, emits a primary collimated beam of X-rays directed at the target, **M**. The primary X-ray beam is attenuated as it transmits through the target by a linear attenuation coefficient (**μ**). The primary X-ray beam that is transmitted through the target material is usually attenuated much more by the primary protective barrier before irradiating an individual located at position **C,** at a distance d_{pri} from the radiation source.

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The leakage radiation ($\dot{X}_L$) from the protective housing and the radiation scattered by the patient are attenuated by the secondary protective barrier(s) before irradiating persons at position **E**, at a distance of d_{sec} from the source and the target. Radiation scattered from the target and primary protective barrier ($\dot{X}_S$) may also reach position **E**. However, the radiation backscattered from the target is usually more significant than that scattered from the primary barrier which may include backscattering, forward scattering and side scattering components.

Tables 11 and **12** giving the minimum protective barrier requirements are included in **Appendix C** of **NCRP Report No. 49** for weekly design exposure limits, **P**, equal to 0.1 and 0.01 roentgen, the maximum design levels for controlled and noncontrolled areas, respectively.

Tables 2, **3** and **4** (**Appendix C**) give suggested values of weekly workload, **W**, use factor, **U**, and occupancy factor, **T**, respectively, for use in those cases where more specific information is not available at the time of planning. The occupancy factors listed in **Table 4** are applied only to nonoccupationally exposed persons (for whom P = 0.01 R).

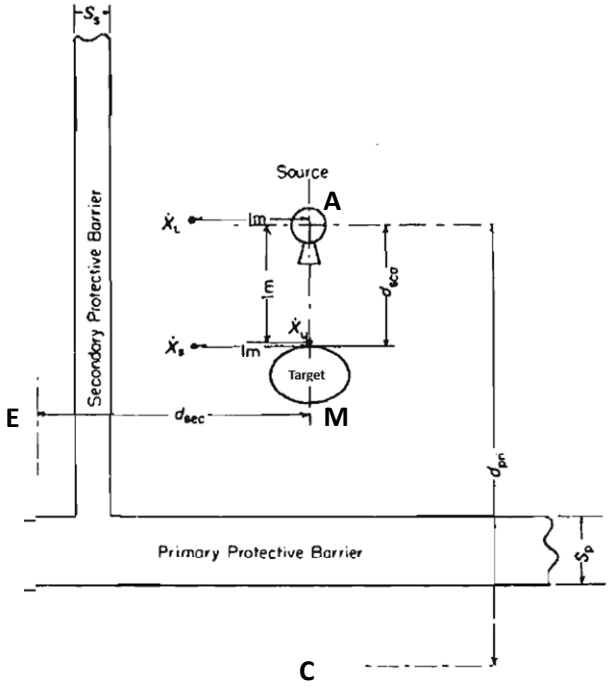


Figure 7. Radiography Vault Geometry

For occupationally exposed persons, the occupancy factor, **T**, usually is assumed to be unity (T = 1). For example, a corridor which is used by the public and which is outside a radiography vault would have an

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occupancy factor of T = 0.25 for the public, but of unity (T = 1) for occupationally exposed persons in the radiography control room. Occupational exposure means exposure of an individual to ionizing radiation in the course of employment in which the individual's normal duties or authorized activities necessarily involve the likelihood of exposure to ionizing radiation.

Occupationally exposed individuals may be assumed to spend their entire work period in **Controlled** areas (T = 1). The fraction of each person's time which will be spent at any one location often cannot be predicted with reliable accuracy. Thus, it must be assumed that all positions from which persons are not specifically excluded are likely to be occupied by a given person for unspecified periods of time. Therefor T may be assumed to be the sum of all time spent by any individual who may be exposed to source of secondary ionizing radiation ($T = \sum T_i$). With these assumptions, all accessible portions of the controlled area *should* be designed with an occupancy factor of unity (T = 1) for occupationally exposed individuals.

However, if the portion of time spent by any person at all locations can be predicted ($T = \sum T_i$), the occupancy factor, **T**, for some areas may be less than unity, but the weekly exposure should not be averaged, over a period of one year, more than 0.1 R. Areas which are not part of the radiography vault enclosure or adjacent areas are not considered to be controlled areas for the purpose of protection of occupants of those areas. Areas within the radiography vault and operator control area that are directly related to the use of the X-ray system are classified controlled areas. Only the radiography vault is classified as a Restricted Area for the purposes of radiation protection.

NCRP Report No. 49, **Tables 11** and **12** (**Appendix C**) provide information about the minimum protective barrier requirements for typical orthovoltage (200 kVp – 500 kVp) radiography installations and were used in the current shielding design to verify numerical calculations. Since Tables 11 and 12 do not include the necessary values of the parameters for 225 kVp, computation of the barrier requirements was necessary and interpolation between the values of Tables 11 and 12 were used to verify calculated barrier thickness including a margin to ensure ALARA conditions at the exterior of the enclosing protective barriers. **NCRP Report No. 49 (Appendix B)** outlines the computations required and illustrates how the values given in the tables of **Appendix C** were obtained. These equations are included in the description of shielding calculations as described in this report. The equations used for computation of barrier requirements and the tabular values obtained from them assume that only one primary X-ray source is producing the radiation exposure at a given reference point. The required barrier thickness ($\mathbf{S_p}$, $\mathbf{S_s}$) are the primary and secondary barrier thicknesses respectively.

In the case described herein for the proposed radiological operations the X-ray system must be completely enclosed in a shielded and interlocked vault. For the purpose of shielding the proposed radiological operations within the radiographic vault we have assumed that all areas exterior to the vault enclosure are unrestricted areas. Therefore, all ionizing radiation transmission through the enclosing protective barriers should have an average peak energy spectrum of less than 50 keV. X-ray

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beam transmission through the enclosing protective barriers should be limited to less than 2% of the unattenuated X-ray beam intensity.

Two of the enclosing protective barriers will be subjected to the collimated primary X-ray beam as part of the expected radiological work operations. Based on information provided by the registrant the north wall designated as **wall section FG** and the **floor of the vault** will be utilized as a primary barrier for 20% (U_w = 0.20) of the X-ray system weekly normalized workload of approximately 900 mA-min/wk. or 180 mA-min/wk. The remaining X-ray system workload will be directed toward the floor (U_f = 0.80) which is constructed on grade with no access or occupancy below the floor.

All other barriers enclosing the X-ray system are considered to be secondary barriers. Secondary barriers are exposed only to isotropic leakage radiation from the X-ray tube housing and first and second scattered radiation fields including sky shine fields generated from backscattered X-rays from the floor is used as a primary barrier. The primary protective barriers and all other secondary barriers are shown on the site drawing found in **Appendix B** of this report.

All shielding calculations are based on the protocols outlined in **NCRP Report 151 - Structural Shielding Design and Evaluation for Megavoltage X-and Gamma-ray Radiotherapy Facilities**.

When the radiation is obliquely incident on a barrier, the required thickness of the barrier will be less than that obtained by the above calculations. The difference between these thicknesses depends on the scattering coefficient (**a**) of the angle of obliquity (**θ)** between the radiation direction and the normal to the barrier, (b) the barrier material, (c) the required attenuation, and (d) the energy of the radiation. If there were no radiation scattering in the barrier material, the relation between the computed thickness, ***S*/cos(θ),** and actual thickness, ***S***, of barrier for obliquely incident radiation would be that illustrated in **Figure 8** below.

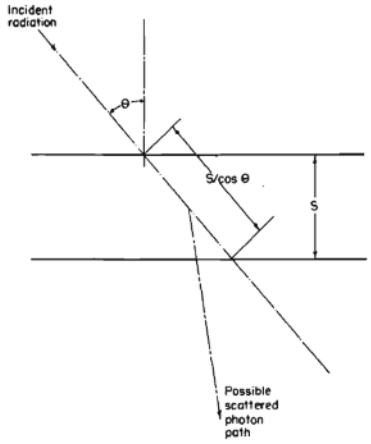


Figure 8. X-ray Photon Scattering Geometry

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However, for large angles of obliquity an incident photon in its scattered path may travel a thickness of less than $S/\cos(\theta)$ before emerging from the barrier. This effect may necessitate a thickness of barrier greater than ***S***. For most practical situations the effect is small and can be treated as a small increase in the approximate thickness, ***S***. If the attenuation required is 1000 and the angle of obliquity is 50 degrees, the increase for concrete barriers is about 2 *HVL* for low energy photons and about 1 HVL for high energy photons. For angles of 60 and 70 degrees, each of the above thicknesses should be increased by 1 and 2 HVL respectively. For lead barriers and a required attenuation of 1000, the increase is only about 1 HVL at 60 degrees. The above approximate determinations are for radiation incident at a single angle.

In calculating the shielding requirements for primary and secondary protective barriers maximum technical factors have been assumed to ensure adequate shielding capacity. For primary X-ray beam interactions with the primary barrier (wall section FG) a 90 degree angle relative to the surface of the barrier has been assumed. The following additional assumptions are made for the purpose of shielding calculations:

- Maximum Peak X-ray Tube Potential: 225 kVp
- Maximum X-ray Tube Current: 30 mA
- Source to Image Receptor Distance (SID) Range: 40 – 120 inches
- Total average weekly normalized workload (W) is assumed to be no greater than 900 mA-min/wk.
- Maximum Collimated X-ray Field Size at SID is assumed to be no larger than 1535 cm^2 (14 in. X 17 in.)
- All existing enclosing protective barriers including walls and roof are assumed to be of standard commercial construction, having no gaps or voids that are not considered as pre-shielding in the calculation of shielding requirements.
- All enclosing protective barrier walls extend from the finished floor to a minimum height of 12 feet to the roof of the vault.
- All shielding calculations assume that the primary collimated X-ray beam impinges on the target and protective barrier at a 90 degree angle relative to the beam axis and surface of the barrier.

The protective barrier shielding calculations are based on the shielding design goals ***P*** for the proposed primary and secondary barriers, the use factor ***U***, barrier occupancy factor ***T***, the X-ray system total weekly normalized workload ***W***, the distance between the source of X-rays and the measurement point 30 cm beyond the protective barrier (d_{sec} and d_{pri}) for primary and secondary barriers, respectively. These variable are related through the following equations. The variable S_p and S_s represent the

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thickness of the primary or secondary protective barrier require to reduce the radiation exposure rate $\dot{X}_u$ and subsequent transmission through the barrier by an amount B_{ux}.

(1) $$P = B_{ux} X_u = B_{ux} \frac{\dot{X}_u t}{(d_{p,s})^2}$$

(2) $$X_u = \frac{\dot{X}_u t}{(d_{ps})^2}$$

Figure 8 describes these variables as they relate to the radiography vault, X-ray system and target geometry.

Computation of Primary Protective Barrier Shielding Requirements

Protective Barrier Shielding For Primary Barrier Wall Section FG

Primary protective barrier shielding calculations for **wall section FG** were performed based on the recommendations of **NCRP Report No. 49**, **Appendices B**, **C** and **D**. The primary protective barrier designated as **wall section FG** must provide sufficient lead equivalent shielding capacity (LESC) rated at the maximum X-ray system technical settings (225 kVp and 30 mA) for the expected weekly normalized workload ***W*** (900 mA-min/wk.) to ensure compliance with the unrestricted area member of the public dose limit requirements of Rule 10A NCAC 15.1611(a). Radiation fields transmitted through the primary protective barrier **wall section FG** must not exceed an 8 hour time weighted average dose rate of 2 mrem per hour or an annual dose equivalent of 100 mrem at the reference point a distance of 30 centimeters from any accessible surface of the barrier. The equations used for the primary barrier calculations are provided below.

(3) $$K_{ux} = \frac{P(d_{pri})^2}{WUT}$$

Where K_{ux} is the number of roentgens (R) per milliampere minute per week for the useful beam normalized at one meter beyond the primary protective barrier, ***P*** is the weekly design goal exposure rate, d_{pri} is the distance from the X-ray beam source to a point 30 cm beyond the primary protective barrier, ***W*** is the normalized weekly workload, **U** is the primary protective barrier use factor and **T** is the protective barrier occupancy factor.

For X-ray energies in the orthovoltage range (200 – 500 kVp), the primary barrier transmission factor is given by setting $K_{ux} = B_{pri}$. To determine the number of tenth value layers (TVLs) required to attenuate the X-ray beam intensity by a factor of 10, equation (1) is used to calculate the value of B_{pri}. The number of tenth value layers required to reduce the X-ray beam intensity to unrestricted area limits at a

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reference point 30 cm beyond the primary barrier into the adjacent unrestricted area behind the primary protective barrier **wall FG** as depicted in the site drawing of **Appendix B** in this report is given by equation (4)

(4) $$\mathbf{n = - \log (B_{pri})}$$

The primary protective barrier thickness $\boldsymbol{S_p}$ is given by equation (5):

(5) $$\mathbf{S_p = TVL_1 + (n-1)TVL_e}$$

The following initial conditions were assumed for the primary protective barrier calculations:

P = 0.02 mSv/wk. (1 mSv/y) for members of the public in an unrestricted area.
$\boldsymbol{d_{pri}}$ = 1.316 m
W = 900 mA-min/wk.
U = 0.20
SSD = 1.016 m
F = 1,535.48 cm^2
T = 0.5

It is recommended that the primary protective barrier be constructed of a minimum nominal thickness of **19.5 mm of lead**. The lead sheet should be laminated onto ¾ inch to 1 inch plywood and installed on the existing enclosing wall.

The transmission factor (B_x) necessary was computed as $\mathbf{B_x = 1.11 \times 10^{-6}}$. The total number of TVLs required for lead and concrete is given by $n = \log_{10}(1/B_x)$ → **5.95** using the initial conditions.

Where: n_{lead} = 1.13

TVL_{lead} = 19.5 mm at 225 kVp

$\mathbf{S_p = TVL_1 + (n-1)TVL_e}$ → n_{lead} (TVL_{lead}) = **19.5 mm**

Direct numerical calculations based on equation (1) above verify the shielding calculation results. Assuming the existing concrete wall construction does not contribute to the required lead equivalent shielding capacity of the primary protective barrier the necessary thickness **19.5 mm** of lead shielding will be needed to achieve the desired dose rate reduction to unrestricted area levels (2 mrem/h) in accordance with the requirements of 10A NCAC 15.1611(a). The average energy of the attenuated beam as it transmits through the lead shielding remains close to 225 kVp, with a slight reduction due to the

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preferential absorption of lower-energy photons. The average energy of the attenuated beam will be slightly lower than 225 kVp, with a more noticeable shift towards lower energies compared to lead.

Lead is highly effective at attenuating X-rays due to its high atomic number and density. It provides superior shielding by absorbing and scattering X-ray photons. Lead absorbs energy primarily through the photoelectric effect (81.68%) and Compton scattering (11.42%), making it highly effective for a wide range of X-ray energies, including higher energy X-rays.

Calculations are based on the NIST data for X-ray interaction cross sections and material densities (https://web-docs.gsi.de/~stoe_exp/web_programs/x_ray_absorption/index.php).

Attenuation of X-rays By Lead (11.34 g/cm^3): The X-ray attenuation and scattering qualities for the lead (6.78 mm) part of the barrier for X-ray beam energies approaching 225 kVp are as follows:

Attenuation and Transmission
Attenuation: 99.7276%
Transmission: 0.2724%
Energy Absorption: 96.99%

Percent Interaction Probability:
Photoabsorption: 81.6771%
Compton Scattering: 11.4152%
Rayleigh Scattering: 6.6352%
Nuclear Field Pair Production: 0.0000%
Electron Field Pair Production: 0.0000%

Interaction Coefficient [cm^2/g]:
Photoabsorption: 0.6217
Compton Scattering: 0.0869
Rayleigh Scattering: 0.0505
Nuclear Field Pair Production: 0.0000
Electron Field Pair Production: 0.0000
Total Attenuation: 0.7674

Vault Floor Shielding

Primary barrier shielding attenuation and transmission calculations for the vault floor have been ignored since the floor is constructed on grade with no occupancy or access below the floor and therefore of no concern in regard to radiation safety. Concrete is a basic construction material used in floor slabs and is usually designed and specified as standard-weight or lightweight depending upon the use of the floor

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slab. Although the floor will be used as a primary barrier in the current case, the floor slab is constructed on grade with no occupancy below the floor. Therefore, there are no additional shielding requirements and standard construction materials may be used in this case.

However, this type floor is of concern in regard to backscattered radiation from the floor when it is used as a primary barrier (U = 0.80). This backscattered radiation does contribute to sky shine radiation generated in the air at the roof protective barrier where it may be further scattered into occupied areas outside of the barrier enclosure. Shielding calculations that account for sky shine radiation are covered in the secondary protective barrier calculations in the next section of this Report.

Computation of Secondary Protective Barrier Shielding

Secondary radiation fields within the radiography vault are more complex than primary X-ray beam radiation fields. Secondary radiation fields are composed of radiation fields scattered from the primary X-ray beam interaction with the target material, primary protective barrier, leakage radiation and sky shine radiation fields.

Leakage Radiation Fields

Leakage radiation refers to the fields transmitted through the X-ray tube housing at 90 degree angles relative to the vault enclosing protective barriers. Leakage radiation consists of radiation fields not related to the collimated primary X-ray beam, generated by the potential voltage applied to the anode and cathode of the X-ray tube when the X-ray tube is powered up but not energized to transmit primary X-rays. This radiation is described as an incidental byproduct of the X-ray generation process and can escape through the housing if not properly shielded.

The leakage radiation field is generally isotropic, meaning it is emitted approximately uniformly in all directions from the X-ray tube housing. This isotropic distribution occurs because the radiation is not confined to the collimated primary beam path and can scatter in various directions. Proper shielding is essential to ensure that the leakage radiation levels remain within safe limits, typically not exceeding 100 mR/h at 1 meter from the housing based on FDA certification requirements. Leakage radiation technique factors are the technique factors associated with the X-ray tube source assembly (i.e., tube housing and beam limiting device) which are used in measuring leakage radiation. In the current case the leakage technique factors are 225 kVp at 30 mA.

Sky Shine Radiation Fields

At X-ray tube potentials above 150 kVp sky shine radiation which is the result of backscattered radiation fields interacting with the air near the vault roof, becomes a substantial concern regarding shielding design. Secondary protective barriers shield against sky shine, leakage and scattered radiation. As these

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types of radiation fields are of different qualities, it is necessary to compute the barrier thickness requirements for each separately.

Leakage Radiation Shielding Computation

The calculations for leakage radiation field shielding of secondary protective barriers was calculated as described in this section. **NCRP Report No. 49** and **Federal Regulations (Title 21 of the Code of Federal Regulations (CFR), Part 1020**, specifically **21 CFR 1020.30** for X-ray equipment operating at X-ray tube potentials above 150 kVp but below 500 kVp , the leakage radiation from the tube housing should not exceed **1 R/hour** at a distance of **1 meter** from the tube housing when operated at maximum X-ray tube and generator conditions, which is typically defined as the maximum rated tube potential. Equation (4) below describes the relationship between the weekly leakage exposure, $\boldsymbol{X_L}$, at the reference point of interest, which is at a distance $\boldsymbol{d_{sec}}$, from the source of radiation, which is the X-ray tube housing, the leakage radiation (0.1 percent) of the useful beam exposure rate $\boldsymbol{\dot{X}_u}$, and the X-ray tube "ON" time $\boldsymbol{t}$.

(6)
$$X_L = \frac{0.001\ \dot{X}_u t}{(d_{sec})^2}$$

Where $\boldsymbol{X_L}$ the weekly leakage exposure at a reference point 30 cm beyond the protective barrier, which is at a distance $\boldsymbol{d_{sec}}$, from the source of radiation and $\boldsymbol{t}$ is the average number of minutes of X-ray beam ON-time in a week. Since $\boldsymbol{(\dot{X}_u)(t)}$ is equal to the normalized workload $\boldsymbol{W}$, in R per week at one meter from the X-ray tube source assembly.

(7)
$$X_L = \frac{0.001\ WUT}{(d_{sec})^2}$$

(8)
$$B_{Lx} = \frac{P(d_{sec})^2 60I}{WT}$$

Required Leakage Radiation Shielding

The leakage radiation field shielding calculations indicated that for the maximum expected leakage technique conditions at 225 kVp / 30mA a dose rate of no more than 1 R/h at 1 meter from the X-ray tube would be present based FDA manufacturer certification requirements. A barrier having a transmission factor, B_{Lx} is required to reduce the weekly radiation field air kerma to P in accordance with equation (7) below:

(9)
$$P = (B_{Lx})(X_L) = \frac{B_{Lx}\ (0.001\ WUT)}{(d_{sec})^2}$$

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For X-ray systems operating below 500 kVp, FDA certified protective tube housings, the maximum allowable leakage radiation field **L** is limited to 1 roentgen (R)in an hour at 1 m from the source when the tube is operating at the maximum rated continuous tube current, ***I.*** Therefore the transmission factor equation for leakage radiation for orthovoltage X-ray systems is in accordance with equation (10) below:

(10) $$B_{Lx} = \frac{P(d_{sec})^2 60 I}{WT}$$

The thickness of barrier, S_L to protect from leakage radiation at the reference point of interest 30 cm beyond the enclosing protective barriers can be computed as follows using the value of B_{Lx} and using the equation (11) below:

(11) $$S_L = \text{N } (HVL) \text{ or n } (TVL)$$

The assumed conditions for secondary protective barrier shielding protection for leakage radiation fields is as follows:

P = 0.02 mSv/wk. (1 mSv/y) air kerma for members of the public in an unrestricted area.
d_{sec} = 2.0 m (minimum distance)
W = 900 mA-min/wk.
U = 1 (Isotropic Exposure)
T = 1

The shielding thickness S_L required to protect the occupied enclosing barriers of the radiography vault from leakage radiation where B_{Lx} = 0.16 is approximately 2.38 mm lead.

S_L = 2.38 mm Lead

Secondary Protective Barrier Shielding Computation for Unrestricted Areas

Secondary radiation for the purpose of shielding calculations is composed of the leakage radiation fields and radiation fields scattered from the target and enclosing barriers. Sky shine radiation is also included in the shielding design calculations for the vault roof.

Unrestricted Areas are defined as areas where there are no radiation exposure restrictions for members of the public who are defined as any individual present who is not occupationally exposed. The shielding

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design for secondary protective barrier that protect unrestricted areas must reduce the radiation fields impinging on those barriers after attenuation and transmission through the barrier at a reference point 30 cm beyond the barrier to the design goals ***P*** for unrestricted areas, or less than an equivalent dose rate of 2 mrem/h (TWA-8)) at a distance of 30 cm beyond the barrier into the unrestricted area.
The shielding design must account for all forms of secondary radiation fields that are likely to intercept the barrier. These radiation fields include scattered radiation fields from the target interaction with the primary X-ray beam, radiation fields scattered from surfaces inside the vault enclosure such as the walls, access door, floor and roof of the radiography vault chamber.

The secondary protective barriers identified for the purpose of calculating unrestricted area shielding requirements are walls **AB**, **BC**, door **CD**, walls **DE**, **EF**, **GA** and the **vault roof**. Where the vault roof is exposed to leakage radiation fields, radiation fields scattered from the target and the enclosing walls of the vault plus backscattered radiation fields from the use of the vault floor as a primary barrier.

The following initial conditions were assumed for each barrier for the purpose of calculating the secondary protective barrier requirements for the designated protective barriers.

Walls AB, BC, DE, and GA
P = 0.02 mSv/wk. (1 mSv/y) air kerma for members of the public in an unrestricted area.
d_{sec} = 2.0 m (minimum distance)
W = 900 mA-min/wk.
U = 0
T = 1

Secondary protective barrier shielding calculations indicate that the proposed additional 6 mm of lead shielding enclosing walls and roof provide sufficient lead equivalent shielding capacity at all scattering angles (45, 90, 135 and 180 degrees) relative to the primary X-ray beam axis and target at the primary protective barrier wall section **FG** (See Appendix B Site Drawing). No additional lead shielding is necessary to ensure compliance with the member of the public dose limits of Rule 10A NCAC 16.1611(a).

S_s = 6 mm Lead

Technical Factors Use for Door CD
P = 0.02 mSv/wk. (1 mSv/y) air kerma for members of the public in an unrestricted area.
d_{sec} = 2.0 m (minimum distance)
W = 900 mA-min/wk.
U = 0
T = 0.25

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Secondary Protective Barrier Shielding Requirements (Door CD)

Secondary protective barrier shielding calculations indicate that the radiography vault access door should be 1.75 inch door constructed of high-security grade 18 gauge steel with a mineral core (approximately 0.071 inches or 0.18 cm steel sheets). The door should be installed in a door frame constructed of 18 gauge steel that is lead lined (0.794 mm).

S_s = 6.39 mm of lead or equivalent LESC

When considering shielding materials for the radiography vault door shielding capacity and efficiency as well as economy play an important role. The most effective shielding materials for this type door are lead and steel. For a balance of cost and efficiency, steel can be used in combination with lead to enhance protection while managing expenses. Wood is not recommended as a primary shielding material but can be used in non-critical areas or as part of a composite structure.

Given the X-ray energy of 225 kVp, we need to determine the additional lead required for a 16-gauge steel door to ensure the radiation intensity 30 cm beyond the door is reduced to unrestricted area levels. For 225 kVp X-rays, 1.59 mm of steel (16 Gauge) provides an attenuation equivalent to approximately 0.2 mm of lead. (LESC = 0.20 mm).

Based on the previous calculation for the required lead thickness where the total LESC value is 6.39 mm of lead for the vault access door as a secondary barrier the combined LESC of the 16 gauge steel door plus addition of a lead core in the door will provide a total LESC of 6.39 mm. Therefore, 6.19 mm of additional lead is necessary inside the door to ensure that the radiation intensity 30 cm beyond the door is reduced to unrestricted area levels.

Technical Factors Use for Wall EF

P = 0.02 mSv/wk. (1 mSv/y) air kerma for members of the public in an unrestricted area.
d_{sec} = 1.0 m (minimum distance)
W = 900 mA-min/wk.
U = 0
T = 0.25

Secondary Protective Barrier Shielding Computation for Controlled/Restricted Areas

The thickness of barrier, S_L, to protect the X-ray system operator from leakage radiation at the point of reference 30 cm beyond the barrier was calculated for the controlled/restricted area wall for the operator control room located in the Microscopy Room. Since the X-ray operator controls will be

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located in the Microscopy Room and this area is likely to be shared by occupationally exposed personnel as well as nonoccupationally exposed members of the public this area will be given a design goal P = 0.02 mSv/wk. (1 mSv/y) air kerma for members of the public in an unrestricted area. For occupationally exposed radiation workers X-ray system operators) the secondary protective barrier shielding calculations indicate that the operator control room barrier should be constructed of 6 mm of lead shielding laminated onto ¾ inch to 1 inch plywood installed onto the existing enclosing barrier wall sufficient to provide adequate protection from leakage radiation fields.

S_s = 6 mm of lead or equivalent LESC

Operator Control / Microscopy Room
The following initial conditions were assumed for the operator control area protective barrier calculations:

P = 0.1 mSv/wk. (5 mSv/y) for occupationally exposed radiation workers.
d_{sec} = 3.30 m
U = 0
W = 900 mA-min/wk.
T = 1
I = 30 mA

Microscopy Room / Operator Control Area Shielding Requirements
Shielding calculations indicate that the operator / control room protective barrier **wall AB** should shielded with a minimum nominal thickness of **6 mm of lead** with no additional shielding necessary to ensure compliance with the dose limit requirements for Rules 10A NCAC 15.1604 and .1611(a).

Scattered Radiation Shielding Computation
Radiation scattered from an irradiated object has a much lower exposure rate and lower average energy, X,, than that of the incident radiation, $\dot{X}_{up}$ and usually

Sky Shine Radiation Shielding Computation
The vault roof is considered a secondary protective barrier for the purpose of shielding. However, due to the use of orthovoltage techniques where some radiography may be performed at X-ray tube potentials from 150 kVp to 225 kVp the risk of sky shine radiation exposures must be accounted for in the shielding design.

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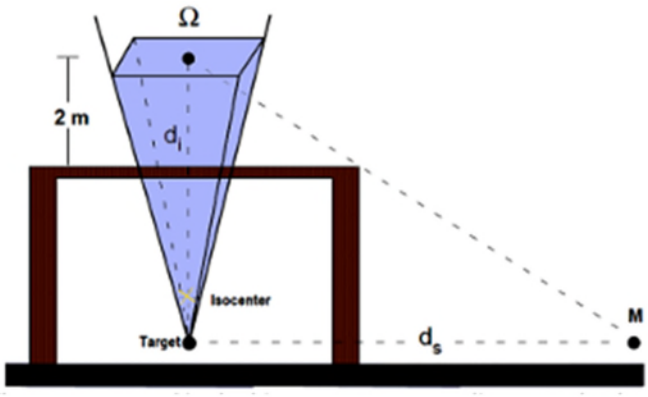


Figure 9. Sky Shine Radiation Geometry

In diagram above, defines a solid angle **Ω** formed by the backscattered X-ray photon beam, $\mathbf{d_i}$ is the vertical distance from the target to a point 2 m above the roof and $\mathbf{d_s}$ is the horizontal distance from the isocenter to the point **M** in terms of meters where the radiation field exposure rate is determined. The equation for the calculation of the sky shine radiation dose rate is given by (4) below.

(12)
$$B_{xs} = 10^{-\left\{1+\left[\frac{(t-\mathrm{TVL}_1)}{\mathrm{TVL}_e}\right]\right\}}$$

(13)
$$\dot{H} = \frac{2.5\times10^{7}\,(B_{xs}\,\dot{D}_0\,\Omega^{1.3})}{(d_i d_s)^2}$$

Where $\dot{H}$ is the dose-equivalent rate, $\dot{D}_0$ represents the x-ray absorbed-dose output rate at 1 m from the target $\mathbf{B_{xs}}$ is the roof shielding transmission factor for photons, represents the X-ray absorbed-dose output rate at 1 m from the target (Gy/h), and the constant 2.5×10^7 is a conversion factor of gray to nano-sievert (nSv), TVL1 and $\mathrm{TVL_e}$ are the first and second tenth-value layers of concrete, respectively. The ceiling thickness is represented by t. Understanding the characteristics and implications of sky shine radiation fields is essential for the effective shielding design of a vault's ceiling in radiological operations. By incorporating appropriate shielding strategies, facilities can ensure compliance with radiation safety standards, protect personnel and the public, and maintain safe and efficient operational environments.

Vault Roof Shielding Design Computation

The estimated sky shine radiation field intensity at the ceiling of a 12-foot-tall vault chamber, due to backscattered 225 kVp X-rays from a concrete and steel-reinforced floor with a weekly workload of 900

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mA-min, could be as high as 13.57 R/h if high level technique factors (E = 225 kVp, I = 30 mA, t > 1 s) are used.

Technical Factors Use for Vault Roof / Plenum
P = 0.02 mSv/wk. (1 mSv/y) air kerma for members of the public in an unrestricted area.
d_{sec} = 5.0 m (minimum distance)
W = 900 mA-min/wk.
U = 0
T = 0.025

Assuming that 225 kVp is the maximum broad beam peak energy of the primary X-ray beam, the calculations for the intensity and scattering angle of sky shine radiation generated by 225 kVp backscattered X-rays are estimated to be relatively insignificant. Therefore, the intensity of sky shine radiation may be as low as 0.000535 mR/h at the vault roof or as high as 13.57 R/h if high level techniques are used a majority of the time for floor based radiography. The mean energy of the backscattered radiation field for a 225 kVp X-ray beam is typically lower than the peak energy due to the scattering process. For 225 kVp X-rays, the mean energy of the backscattered radiation field is expected to be generally around 70 to 90 keV. This range accounts for the X-ray energy loss during scattering interactions, such as Compton scattering, which reduces the energy of the scattered photons. The estimated scattering angle of sky shine radiation is approximately 74.48 degrees which could potentially expose the adjacent occupied areas outside of the vault enclosure to lower energy radiation fields that may exceed ALARA levels.

Actual survey measurements above the vault roof and in the occupied areas adjacent to the vault enclosure must be performed to accurately document the combined effects of geometry, material properties, and any potential scattering effects to verify the sky shine shielding calculations.

Recommended Vault Roof Shielding

The calculations for potential sky shine radiation indicate that the radiation field intensity is likely to be on the lower end of the spectrum with mean peak energies of the radiation expected to be in the range of 70 to 90 keV. The sky shine and backscattered radiation field calculations as described above indicate that the vault roof deck should be constructed of commercial grade concrete poured over an 18 gauge steel deck. The recommended existing construction concrete floor poured into an 18 gauge steel deck and covered with **6 mm of lead** laminated onto ¾ inch to 1 inch plywood will provide sufficient radiation shielding as a secondary barrier.

Based on the calculations, the total intensity of the radiation field, including backscattered and leakage radiation, at a reference distance of 30 cm beyond the floor deck is approximately 0.0404 mR/h. This is well below the unrestricted area radiation dose limit of 2 mR/h. Therefore, this type of floor

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construction will ensure that the radiation dose limits for unrestricted areas are met under the given conditions. This floor deck construction is similar to the standard construction for commercial facilities and will be sufficient to shield against sky shine radiation and ensure that the does limits requirements of Rule 10A NCAC 15.1611(a) are met.

IV. SUMMARY OF PROTECTIVE BARRIER SHIELDING RECOMMENDATIONS

All protective barriers must meet the regulatory requirements for annual occupational dose limits for controlled and restricted areas (10A NCAC 15.1604, and .1610) and member of the public dose limits for all unrestricted areas (10A NCAC 15.1611(a)). The protective barrier shielding requirements for the proposed radiography vault are based on the recommendations of NCRP Report Nos. 49, 147 and 151. Protective barrier shielding calculations for all primary and secondary barriers enclosing the proposed X-ray system and radiographic operations were performed based on the equations of **NCRP Report No. 49**, **Appendices B**, **C** and **D**.

Discussion of Shielding Requirements and Recommendations

The primary and secondary protective barrier shielding requirements were calculated assuming the highest expected radiography technical factors, radiation transmission and attenuation conditions, average weekly X-ray system workloads and barrier occupancy factors to ensure that the installed protective barrier shielding capacity is sufficient to ensure the ALARA requirements of Rule 10A NCAC 15.1603(b) and the dose limit requirements of Rules 10A NCAC 15.1604 and .1611(a).

All protective barriers must meet the regulatory requirements for the annual occupational dose limits for controlled and restricted areas in accordance with the provisions of Rules 10A NCAC 15 .1604, and .1610; and member of the public dose limits for all unrestricted areas in accordance with the provisions of Rule 10A NCAC 15 .1611(a).

The enclosing walls (**AB, BC, DE, EF, and GA**), access door **CD**, and ceiling, for the proposed radiography vault were assessed as secondary protective barriers for the purpose of determining if the lead equivalent shielding capacity (LESC) value of the proposed construction materials of these are sufficient to ensure compliance with the occupational and member of the public dose limits of Rules 10A NCAC 15.1604 and .1611(a), respectively. Wall section **FG** and the vault floor were assessed as primary protective barriers as described in the report.

The protective barrier shielding assessment found that the enclosing protective barrier walls (**AB, BC, DE, EF, and GA**) should be shielded with **6 mm of lead** laminated to ¾ inch to 1 inch plywood installed onto the existing enclosure wall construction. No additional shielding will be required for these walls based on the expected X-ray system technical factors, weekly normalized workloads, and occupancy factors for these barriers.

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The shielding assessment for the ceiling/roof of the vault indicated that there is a significant probability of some level of sky shine radiation at X-ray technical factors that exceed 150 kVp and 30 mA and 0.50 seconds exposure time. In the context of the proposed radiological operations—particularly those involving the use of orthovoltage radiography (high-energy X-rays in the energy range of 200 – 225 kVp) it is important to evaluate and understand the impact of sky shine radiation on the shielding design for the ceiling of the vault.

Sky shine radiation refers to the scattered radiation that can escape from an industrial or medical radiation facility into the surrounding environment, specifically from high-energy X-ray beams. This phenomenon occurs when X-rays emitted from a source interact with structures and surfaces, such as walls, floors, and ceilings, creating scattered radiation fields that may then reflect off surfaces and travel upward into the atmosphere and then be scattered to points outside of the vault enclosure. These X-rays can scatter in various directions, and when they encounter the ceiling of a vault or room, some of this radiation can be directed further into the space above and areas adjacent to the vault enclosure, potentially reaching areas where personnel or members of the public may be present in unrestricted areas.

The significance sky shine radiation fields for the shielding of the vault roof, plenum and facility roof structure includes ensuring that the vault roof provides adequate shielding to minimize the amount of scattered radiation entering areas of the building roof that may be occupied by maintenance personnel and employees that are working in the adjacent areas such as the conservation studio, offices, and shop. The materials and thickness of the vault roof must be designed to effectively attenuate sky shine radiation.

Regulatory dose limits for radiation exposure regarding members of the public in unrestricted areas must be adhered to. This necessitates careful consideration of factors like the expected scattering from the floor, the angle of incidence, and the energy of the radiation. Museum employees and visitors within or near the radiological operation space need protection from potential excessive exposure caused by sky shine. Adequate shielding contributes to maintaining safe working conditions and minimizing health risks. Since the radiography vault is adjacent to areas accessible by the public, it is crucial to design shielding that mitigates sky shine exposure to ensure public safety and confidence in the facility's operational practices. Table 1 below is a summary of enclosing protective barrier shielding calculations for the radiography vault.

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Table 1. Enclosing Protective Barrier Description

Protective Barrier Number	Protective Barrier Identifier	Protective Barrier Type (Wall, Door)	Barrier Location	Shielding Design Goal (mGy/wk) (P)	Exisring Protective Barrier Composition	LESC Value (mm Pb)	Barrier Transmission Type	Barrier Protected Area Type	Area Protected	Occupancy Factor (T)	Use Factor (U)	Weekly Normalized Workload (W) (mA-min/wk)
1	AB	Wall	Interior	0.1	Concrete	3-4	S	S/C	Operator / Microscopy	1	0	900
2	BC	Wall	Interior	0.02	Concrete	3-4	S	S/UR	Conservation Studio	1	0	900
3	CD	Door	Interior	0.02	Not Installed	<0.01	S	S/UR	Conservation Studio	0.25	0	900
4	DE	Wall	Interior	0.02	Concrete	3-4	S	S/UR	Conservation Studio	1	0	900
5	EF	Wall	Interior	0.02	Concrete	3-4	S	S/UR	Conservation Stairwell	1	0	900
6	FG	Wall	Interior	0.02	Concrete	7-8	P	P/UR	Conservation Office	1	0.2	900
7	GA	Wall	Interior	0.02	Concrete	3-4	S	S/UR	Shop	1	0	900
8	Ceiling	Ceiling	Interior	0.02	Concrete	2.0-2.5	S	S/C	Plenum / Roof	0.025	0	900
9	Floor	Floor	Interior	N/A	Concrete	2.5-3.0	P	P/C	Grade	0	0.8	900

P – Shielding Design Goal
S – Secondary Radiation
P – Primary Radiation
C- Radiation Controlled Area
UR – Unrestricted Area

Table 2. Recommended Protective Barrier Shielding Construction

Protective Barrier Number	Protective Barrier Identifier	Protective Barrier Type (Wall, Door)	Recommended Shielding	Shielding Index
1	AB	Wall	Existing plus 6 mm lead	1.5
2	BC	Wall	Existing plus 6 mm lead	1.5
3	CD	Door	1.75" 18 Ga. Steel (6 mm Lead Core) Door w 18 Ga. Lead Lined Frame	1.5
4	DE	Wall	Existing plus 6 mm lead	1.5
5	EF	Wall	Existing plus 6 mm lead	1.5
6	FG	Wall	Existing plus 19.5 mm lead	2.5
7	GA	Wall	Existing plus 6 mm lead	1.5
8	Ceiling	Ceiling	Existing plus 6 mm lead	1.5
9	Floor	Floor	Standard Construction Floor Slab	N/A

B. Recommendations For Protective Barrier Construction and Installation

Constructing the radiography vault for Peltec X-ray system requires careful consideration of shielding, safety, and regulatory compliance. The following recommendations are provided for the construction of the proposed radiography vault enclosing protective barriers.

The proposed radiography vault will need to be constructed with both primary and secondary protective barriers. Only two primary protective barriers are planned for the radiography vault. These are the north wall (wall section FG) of the radiography vault enclosure and the floor.

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The secondary protective barriers include all other walls, the access door, and the roof of the vault. The walls and access door will be exposed to secondary radiation fields resulting from scattered radiation from the primary beam target, enclosing walls, floor, vault roof and image receptor; and X-ray tube leakage radiation fields only.

However, X-ray systems that operate at energies above 150 kVp the is a high probability of the generation of sky shine radiation fields. These radiation fields originate from backscattered radiation fields when the floor of the vault is used as the primary protective barrier. If sufficient shielding is not provided for the vault roof sky shine radiation fields can leak out into the unrestricted areas of the adjacent office spaces, shop, and conservatory studio. Therefore, additional secondary shielding will be necessary for the vault roof to ensure shielding against sky shine radiation fields.

Primary Protective Barrier Shielding: The primary collimated X-ray beam is expected to have the highest probability of transmission through the protective barrier it directly impinges on. Since it is difficult to normalize the kVp distribution due to the wide variability technique factors that may be used in the expected radiography procedures that may be conducted in the radiography vault, the most conservative estimate is to assume the highest operational technical setting for the device (225 kVp, 30 mA) for the determination of shielding requirements.

For X-ray tube potentials of 225 kVp and 30 mA, a conservatively high level of **lead** thickness of **19.5 mm** is required to attenuate the transmitted radiation to less than 1% of the primary X-ray beam intensity at a reference point 30 cm beyond the barrier.

The proposed radiography vault primary protective barrier construction should include a minimum of 19.5 mm lead shielding laminated onto ¾ inch to 1 inch plywood installed onto the existing enclosure walls to provide sufficient primary barrier shielding to ensure compliance with Rule 10A NCAC 15.1611(a).

Secondary Protective Barriers Shielding: Secondary protective barriers provide shielding against scattered and leakage radiation fields. Additional shielding may be necessary in areas such as the vault roof where sky shine radiation fields may be present at sufficient energies and field intensities to potentially expose individuals to radiation fields in excess of the ALARA limits in unrestricted areas adjacent to the vault enclosure.

The proposed radiography vault secondary protective barrier construction should include a minimum of 6 mm lead shielding laminated onto ¾ inch to 1 inch plywood installed onto the existing enclosure walls to provide sufficient primary barrier shielding to ensure compliance with Rule 10A NCAC 15.1611(a).

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Wall and Door Construction

Walls and Roof: The radiography vault walls must be constructed with appropriate shielding material. All joints and seams must be properly sealed or overlapped to prevent radiation leakage. Walls should be constructed such that there are gaps, voids or other variations in the shielding material density that may reduce the mass attenuation coefficient of the walls and vault roof.

The proposed radiography vault secondary protective barrier construction should include a minimum of 6 mm lead shielding laminated onto ¾ inch to 1 inch plywood installed onto the existing enclosure walls to provide sufficient secondary protective barrier shielding to ensure compliance with Rule 10A NCAC 15.1611(a).

Door Construction and Installation

The access door to the radiography vault must have a minimum lead equivalent shielding capacity (LESC) equivalent to that of the wall in which it is installed. The access door must be constructed and installed to ensure that the door opening is properly sealed against radiation leakage and are interlocked to prevent accidental entry and radiation exposure. Doors require special consideration to ensure adequate protection without sacrifice of operational efficiency. The joints between lead sheets **should** be constructed such that their surfaces are in contact and with an overlap of not less than 1 cm or ½ inch, or twice the thickness of the sheet, whichever is greater. Welded, or burned, lead seams are satisfactory if the lead equivalence of the seams is not less than that required of the barrier. There are two types of door that may be considered for entry into the vault.

The proposed radiography vault door lead equivalent shielding capacity should at a minimum be equal to that of the secondary protective barrier wall construction. The X-ray vault door should include a minimum of 6 mm lead shielding laminated into 1¾ inch 18 gauge hollow steel door to provide sufficient secondary protective barrier shielding to ensure compliance with Rule 10A NCAC 15.1611(a).

Vault Access Door Recommendations

The access door must be constructed of materials that provide equivalent shielding capacity as required for wall **BE** as shown in the site drawing in **Appendix B** of this Report. Two types of door systems are available for the radiography access door. A sliding door may be installed for the radiography vault entry similar those shown below but without a window installed.

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Figure 10. Railed Motorized Sliding Shielded Door



Figure 11. Manually Operated Sliding Shielded Door

Additionally, a more traditional type hinged door may also be installed for the radiography vault entry as shown below.

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Figure 12. Traditional Solid Core Wood Door (Lead Core)

Lead Lined Door Specifications

The lead equivalent shielding capacity (LESC) of the enclosing secondary protective barrier walls and access door should be of equal LESC values for secondary radiation fields. The LESC value for the wall is approximately **6 mm of lead**. Therefore, the vault access door have the same or greater LESC value of **6 mm of lead** to ensure compliance with requirements of the NC Administrative Code – Rule 10A NCAC 15.1611(a).

The radiography vault access door may be of a hinged or sliding type door. There are a number of options available. Specifications provided below should be considered for the shielded access door:

6. **Material**:

   Core: Solid core wood or hollow metal filled with lead.

   Lead Thickness: Equivalent to 6.13 cm of lead, which can be achieved by using multiple layers of lead sheeting.

7. **Construction**:

   Lead Lining: The door should be lined internally with lead sheets that cover the full height and width of the door.

   Frame: Lead-lined hollow metal frames constructed with 16 or 18 gauge steel, lined with sheet lead to match the door's lead thickness.

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8. **Dimensions**:

   Thickness: The door should be thick enough (1.75 in. or greater) to accommodate the required lead lining while maintaining structural integrity.

   Size: The door is customizable to fit the specific dimensions of the vault entry.

9. **Hardware**:

   Hinges: Heavy-duty continuous hinges to support the weight of the lead-lined door.

   Heavy Duty Motorized Rail System: A motorized rail system to accommodate a sliding access door.

   Locks: Lead-lined locksets to ensure no radiation leakage through the locking mechanism.

   Seals: Lead-lined door sweeps and shielded thresholds to minimize gaps and prevent radiation leakage.

10. **Additional Features**:

    Automation: Motorized options for ease of use, especially for heavy doors. Shielded doors can weigh 500 lbs. or more.

    Fire Rating: Fire-rated options available if required.

To ensure that either of the doors proposed possess the appropriate lead equivalent shielding capacity the door should be purchased from a vendor that specializes in doors designed for radiation shielding. Our preferred vendor for this is MarShield. I have enclosed a door spec sheet at the end of this Report for your review.

Vault Roof Construction Recommendations

The construction of the vault roof **shall** be such that the shielding materials at a minimum will ensure that the protective barrier shielding requirements for secondary protective barriers as described in Rule 10A NCAC 15.1611(a) are met. The vault roof protective barrier lead equivalent shielding capacity shall be constructed of materials that provide adequate protection from secondary and leakage radiation fields, including sky shine radiation fields.

It is recommended that the vault roof be constructed of a standard commercial grade concrete slab poured over an 18 gauge steel deck that **should include a minimum of 6 mm lead shielding laminated onto ¾ inch to 1 inch plywood** to ensure compliance with the member of the public dose limits of Rule 10A NCAC 15.1611(a).

Vault Enclosure Wall Construction

The enclosing protective barrier shielding of the radiography vault **shall** be so constructed that the shielding capacity is not impaired by voids or variations in density in the concrete, gaps at joints,

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openings for the access door, ducts, pipes, etc. passing through the barriers, or by conduits, service boxes, etc. embedded in the barriers. The extension of lead shielding into materials such as concrete may be required to attenuate the radiation scattered in the concrete around ducts, pipes, etc. passing through the barriers, or by conduits, service boxes, etc. embedded in the barriers. Baffles are usually required for door sills exposed to secondary radiation fields that are side scattered when the floor is used as a primary barrier. Joints between different kinds of protective material **should** be constructed such that the overall protection of the barrier is not impaired and radiation leakage does not take place.

Openings in protective barriers for doors, windows, ventilating ducts, conduits, pipes, etc. may require radiation baffles to ensure that the required degree of overall protection is maintained. Whenever possible, the opening **should** be located in a secondary protective barrier where the required shielding thickness is less. The design of the baffles will depend upon a number of factors. These include:

- Energy of the radiation field impinging on the material.
- The orientation and field size of collimated useful primary X-ray beam.
- The size and location of opening in the protective barrier.
- The geometrical relationship between the radiation source and the opening.
- The geometrical relationship between opening and persons, materials or instruments to be protected.

For orthovoltage (200 kVp - 500 kVp), the wall shielding **should** extend to the ceiling barrier (vault roof) to mitigate the effects of sky shine radiation fields in adjacent areas outside of the vault enclosure. Where ducts terminate at a grille in the wall surface of a primary protective barrier, a lead-lined baffle may be required in front of the grille; the baffle must be at a sufficient distance to permit adequate flow of air and must extend far enough beyond the perimeter of the opening in order to provide the required degree of protection.

Service boxes, conduits, etc. imbedded in concrete barriers may require lead shielding to compensate for the displaced concrete. For example, if the outside diameter of a steel conduit is large, if the conduit passes through the barrier in line with the useful beam, or if the concrete does not fit tightly around the conduit, compensatory shielding is required.

Where supplementary lead shielding is required, its thickness should be at least equal to the lead equivalence of the displaced concrete. The lead equivalence of the concrete will depend upon the energy of the radiation. The shielding should cover not only the back of the service boxes, but also the sides, or extend sufficiently to offer equivalent protection.

Conduits passing through protective barriers should have sufficient bends to reduce the radiation to the required levels.

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Radiography Vault Operator Control Protected Area Construction

The X-ray system operator control station **shall** be located outside the radiography vault in a protected area and provided with secondary protective barriers sufficient to ensure that the occupational dose limits required by Rule 10A NCAC 15.1604 are met. The proposed location of the X-ray system operator controls and operator protected area is designated to be in the Microscopy Room. If other individual members of the public not associated with the radiographic procedures will be present or working in this area during radiographic procedures the protective barriers for the operator control area shall at minimum be sufficient to meet the dose limit requirements of Rule 10A NCAC 15.1611(a).

The wall of the operator protective area is adjacent to the radiography vault and is composed of the wall labeled **AB** as showing the site drawing in **Appendix B** of this Report. This wall shall be constructed as a secondary protective barrier in accordance with the recommendations for construction of the secondary protective barrier shielding requirements as described herein.

Recommendations For The Radiography Vault Safety Device Installation

Rule 10A NCAC 15.1615 requires the following safety devices must be installed in the radiography vault to ensure that the radiography vault operates within safe limits, protecting both personnel and the public from excessive radiation exposure:

(a) The licensee or registrant shall ensure that each entrance or access point to a High Radiation Area has at least one of the following features:

(1) A control device that, upon entry into the area, causes the level of radiation to be reduced below that level at which an individual might receive a deep-dose equivalent of 0.1 rem (1 mSv) in one hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates;

(2) A control device that energizes a conspicuous visible or audible alarm signal so that the individual entering the high radiation area and the supervisor of the activity are made aware of the entry; or

(3) Entryways that are locked, except during periods when access to the areas is required, with positive control over each individual entry.

(b) In place of the controls required by Paragraph (a) of this Rule for a high radiation area, the licensee or registrant may substitute continuous direct or electronic surveillance that is capable of preventing unauthorized entry.

(c) Any licensee, registrant or applicant for a license or registration may apply to the agency for approval of alternative methods for controlling access to high radiation areas. The agency will approve alternatives if the licensee, registrant or applicant demonstrates that the alternative methods of control will prevent unauthorized entry into a high radiation area.

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(d) The licensee or registrant shall establish the controls required by Paragraphs (a) and (c) of this Rule in a way that does not prevent individuals from leaving a high radiation area.

Based on **NCRP Report No. 49** and the requirements of the North Carolina Administrative Code, Rule **10A NCAC 15 .1615 - Control Of Access To High Radiation Areas**, the following safety devices are required for the subject permanent radiography vault operating an orthovoltage X-ray system with a maximum tube voltage of 225 kVp and 30 mA tube current:

1. Access Control Devices: Each entrance or access point to the High Radiation Area of the vault must have a control device that terminates or reduces the radiation within the vault upon entry to below the threshold where an individual might receive a deep-dose equivalent of 0.1 rem (1 mSv) in one hour at 30 cm from the radiation source. An electronic interlock must be installed on the vault access door

a. Alarm Systems: A control device should be installed that activates a visible or audible alarm signal to alert individuals inside the vault of the existence of a High Radiation Area.

b. Locked Entryways: The access door to the radiography vault must be locked to entry from the outside, except during periods when access is required, with positive control over each individual entry. An exit button must be installed on the door such that the door may be opened from the inside in accordance with OSHA 29 CFR § 1910.36(d).

2. Surveillance: Rule 10A NCAC 15.1622(b) requires continuous direct or electronic surveillance of the vault and X-ray system that is capable of detecting unauthorized entry into the high radiation area of the vault. It is recommended that a video surveillance camera be installed within the radiography vault that allows the radiographer to view the interior of the vault and X-ray system during radiological operations.

3. **Emergency Controls**: Emergency controls must be installed such as emergency shutoff buttons and interlocks to ensure that the X-ray system can be quickly de-energized in the event of an emergency.

a. Emergency Stop Buttons: Easily accessible emergency stop buttons should be installed inside the vault and in the Operator Control Room to enable personnel to immediately shut down the X-ray system in case of an emergency or equipment malfunction.

b. Interlock Systems: Interlocks **shall** be provided for access doors into the radiography vault. Electronic interlock systems must be installed on the vault access door that are designed to automatically shut off the X-ray beam if the door to the vault is opened during radiography operations or if the vault door has not be secure locked prior to radiological operations.

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4. **Warning Signs and Lights**:

a. Warning Signs: Clearly visible warning signs in accordance with requirements of Rule 10A NCAC 15.1624, including the radiation symbol and appropriate warning messages must be posted indicating the presence of **High Radiation Areas** in the **Restricted Area** within the vault when the X-ray system is energized.

b. Warning Lights: Illuminated warning lights should be installed near the access door outside the vault that indicate when the X-ray system is in operation.

5. Radiation Monitoring Devices:

a. Area Radiation Monitors: Radiation area monitors should be installed to continuously measure radiation levels within the vault during radiography operations and ensure that the radiation source is OFF and alert personnel if radiation levels exceed background levels.

b. Personal Dosimeters: Personal dosimeters are required for all personnel working in or near the radiography vault to monitor individual radiation exposure in accordance with the requirements of Rule 10A NCAC 15.1614(1). Personnel dosimetry device services may be secure by an NVLP accredited service provider that is registered in North Carolina to provide these services. A list of registered dosimetry service providers can be found at the following link: https://radiation.ncdhhs.gov/xray/documents/rptSrvListingClassVIII.pdf.

6. Communication Systems:

a. Intercom System: An intercom system installed within the vault is recommended to allow communication between personnel inside the vault and those in the Operator Control Room, ensuring coordination and safety during radiography operations.

X-ray System Installation

The local components of the Peltec 2250 X-Series industrial X-ray system shall be located and arranged and installed to include sufficient protective barrier shielding, access controls and safety devices to ensure no radiation fields exist in any area surrounding the local components or the vault enclosure that could result in an ionizing radiation dose to an individual present 30 cm from the enclosure in excess of the member of the public dose limits required by Rule 10A NCAC 15.1611(a).

The X-ray system shall be installed as a stationary X-ray system at the specified fixed location within the radiography vault as described herein. The X-ray system shall be installed such that the X-ray field at the point of intersection of the collimated primary X-ray beam at the maximum primary source to image receptor distance (SID) aligns perpendicularly with the image receptor and the primary protective barrier. "X-ray field" means that area of the intersection of the useful beam and any one of the set of

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planes parallel to and including the plane of the image receptor, whose perimeter is the locus of points at which the exposure rate is one-fourth of the maximum in the intersection.

The X-ray system shall be installed such that the primary X-ray beam may only be directed toward the vault wall section designated as **FG** as shown in the site drawing in **Appendix B** and the floor. The primary X-ray beam may not be directed toward any designated secondary protective barrier. Mechanical or electrical means *shall* be provided to prevent the useful beam from striking secondary protective barriers. Restricting the primary X-ray beam orientation will limit the area requiring primary protective barriers to that which can be struck by the useful beam plus a suitable margin as described in the section on beam collimation.

The X-ray system movement along the axis of the primary X-ray beam shall be mechanically or electronically restricted to a minimum SID shall be 40 inches and the maximum SID shall be 72 inches for wall section **FG**.

X-ray Field Collimation
The following shall be required to ensure that the X-ray beam is directed toward the designated primary protective barrier during radiography:

1. The X-ray system shall be provided with means to limit the X-ray field in the plane of the image receptor so that such field does not exceed each dimension of the image receptor by more than two percent of the maximum SID when the axis of the X-ray beam is perpendicular to the plane of the image receptor.
2. There shall be provided a means for stepless adjustment of the size of the collimated X-ray field. The minimum field size at a SID of 100 centimeters shall be equal to or less than five centimeters by five centimeters.
3. The X-ray system shall also be provided with means to align the center of the X-ray field with the center of the image receptor to within two percent of the SID.
4. Means shall be provided for visually defining the perimeter of the X-ray field. The total misalignment of the edges of the visually defined field with the respective edges of the X-ray field along either the length or width of the visually defined collimated field shall not exceed two percent of the distance from the source to the center of the visually defined field when the surface upon which it appears is perpendicular to the axis of the X-ray beam.
5. Means shall be provided to indicate when the axis of the X-ray beam is perpendicular to the plane of the image receptor, to align the center of the X-ray field with respect to the center of the image receptor to within two percent of the SID, and to indicate the SID to within two percent.

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6. The beam limiting device (collimator) shall numerically indicate the field size in the plane of the image receptor to which it is adjusted.
7. Indication of X-ray field dimensions and SID's shall be specified in inches or centimeters and shall be such that aperture adjustments result in x-ray field dimensions in the plane of the image receptor which correspond to those of the image receptor to within two percent of the SID when the beam axis is perpendicular to the plane of the image receptor.

X-ray System Controls Installation

The radiation exposure control for the X-ray system must meet the following requirements:

1. The X-ray system controls must be located in a protected area outside of the radiography vault.
2. The X-ray system control shall be permanently mounted in the protected area such that the operator is required to remain in the protected area during radiography.
3. Means shall be provided to terminate the exposure after a preset time interval, preset product of current and time, a preset number of pulses or a preset radiation exposure to the image receptor.
4. It shall not be possible to make an exposure when the timer is set to a zero or "off" position if either position is provided.
5. Control over X-ray exposures must be in accordance with the following requirements:
    a. The X-ray control shall provide visual indication observable at or from the operator's protected position whenever X-rays are produced.
    b. A signal audible to the operator shall indicate that the exposure has terminated.
    c. Key actuated power control or password (PC workstation GUI) controlled access to the X-ray system controls must be present at the operator the control panel.



Figure 13. Key Actuated Control

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Figure 14. Peltec X-ray System Control Panel

Onsite Inspections During Construction

Visual inspection during construction is advantageous in ensuring compliance with specifications and revealing faulty materials or workmanship which can be remedied more economically at this stage than later. Inspections should be performed by the physicist qualified expert or their designee to ensure the requirements of the shielding design are being met during the vault construction phase of the project.

Inspections during construction should include, where applicable verification of lead installation and thickness, observation of the degree of overlap of lead sheets or joints between lead, steel, concrete and other barrier material and inspection of the lead shielding behind switch boxes, lock assemblies, etc., recessed in protective barriers, inspection of the location and action of door interlock switches and warning lights, and verification of specified lead dimensions in baffles or in barriers.

Change Orders

All changes proposed or requested by the registrant or installers that may render the acknowledged plan review no longer accurate, must be reviewed by the health physicist / qualified expert, and authorized prior to any changes being made. The health physicist / qualified expert shall then submit an amended document to NCRPS indicating all authorized changes to the acknowledged plan review based on “as constructed plans.”

Post Installation Radiation Surveys

The North Carolina Administrative Code, Rule 10A NCAC 15.0804(b)(1)(A) requires that an area radiation survey and protective barrier shielding assessment be performed within 30 days after initial operation of the X-ray system as set forth by Rule 10A NCAC 15.1613(a) and (b) to determine the adequacy of

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primary and secondary protective barrier shielding regard the radiography vault construction and to assess the level of regulatory compliance with the relevant and applicable provisions on Rules 10A NCAC 15.0500 and .0800.

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V. REGULATORY COMPLIANCE GUIDEANCE

The primary regulatory requirements for the proposed radiography vault are the North Carolina General Statutes; G.S. 104E-2; 104E-7, 104E-10104E-7(a)(2); 104E-12(a) and the provisions of **10A NCAC 15.0500 - Safety Requirements For Industrial Radiography Operations**, **10A NCAC 15.0800 - Requirements For Non-Human Use Of Radiation Generating Devices** and **10 CFR § 34.33 - Permanent Radiographic Installations**.

10A NCAC 15.0500 establishes radiation safety requirements for persons utilizing sources of ionizing radiation for industrial radiography.

10A NCAC 15.0800 provides special requirements for use of ionizing radiation generating devices (RGDs) operating above five thousand electron volts (5 keV), but below one million electron volts (1 MeV) that are in addition to requirements in sections .0100, .0200, .0500, .1000 and .1600 of 10A NCAC 15.

The proposed radiography vault is defined under 10A NCAC 15.0802(22) as a permanent radiographic installation. The term "permanent radiographic installation" means an RGD utilized in an enclosed shielded room, cell, or vault that allows entry of an authorized individual into the restricted area when the RGD is not energized. The proposed Peltec 2250 X-Series industrial X-ray system shall be operated as a permanent radiography installation.

10 CFR § 34.33 - Permanent Radiographic Installations establishes the requirements for industrial radiography operations.

The primary regulatory authority for the proposed radiographic operations is the State of North Carolina General Statute 104E-7 and the North Carolina Administrative Code, Title 10A, Chapter 15 – Radiation Protection (10A NCAC 15). The applicable sections of the 10A NCAC 15 regulations are Sections .0100, .0200, .0500, .0800, .1000 and .1600. The following section provides a summary of the requirements for permanent industrial radiography installations under the provisions of the North Carolina Administrative Code.

Radiation Protection Program Requirements
A radiation protection program (RPP) must be developed, documented, and implemented in a manner that aligns with the scope and extent of the licensed activities. A compliant radiation protection program under 10 CFR Part 20 and 10A NCAC 15.1600 must include the following primary elements:

Development and Documentation: The registrant shall develop, document, and implement a radiation protection program commensurate with the scope and extent of the registered activities. The radiation protection program documentation and implementation must be sufficient to ensure compliance with the provisions of Section 10A NCAC 15.1600.

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Radiation Protection Program Policies and Procedures

An industrial radiography radiation protection program for using orthovoltage X-ray systems in an art museum conservatory should include the following key policies and procedures:

1. **Radiation Safety Management**

Radiation Safety Officer (RSO): Designate a qualified RSO responsible for overseeing the radiation protection program and ensuring compliance with regulations.

Training and Certification: Ensure all personnel operating X-ray equipment are properly trained and certified in radiation safety and the specific use of orthovoltage X-ray systems2.

2. **External Radiation Exposure Control**

ALARA Principle: Implement procedures to keep radiation exposure "As Low As Reasonably Achievable" (ALARA) by using time, distance, and shielding effectively.

Dosimetry Program: Provide personal dosimeters to monitor radiation exposure for all personnel working with or near X-ray equipment.

Area Monitoring: Regularly monitor radiation levels in and around the X-ray usage area to ensure they remain within safe limits.

1. **Equipment and Facility Requirements**

Facility and Equipment Registration: In accordance with Rule 10A NCAC 15.0203. Unregistered radiation generating devices and the facility for which radiological operations will be conducted area required to apply for registration of the facility and each radiation generating device in possession or use within 30 days following initial operation of that facility and each radiation generating device. Application for registration must be completed on NCRPS forms found at: applic.htm. The applicant shall complete all required forms and provide all information required by the forms and accompanying instructions. The registration of the first radiation generating device at a facility constitutes registration of the facility itself. The registrant's management shall designate on the application form an individual who shall be responsible for radiation protection, the radiation safety officer (RSO). The name of the person responsible for radiation protection in the facility must be provided with the application for registration; including documentation of adequate RSO education, training experience or required certifications. Equipment application forms must include the manufacturer, model number, serial number and type of each radiation generating device located within the facility.

Shielding Design: The registrant shall ensure proper shielding of X-ray equipment and surrounding areas to protect personnel and the public from radiation exposure.

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Maintenance and Calibration: Establish a routine maintenance and calibration schedule for X-ray equipment to ensure it operates safely and effectively.

4. **Operational Procedures**

Standard Operating Procedures (SOPs): Develop and implement SOPs for the safe operation of X-ray equipment, including startup, shutdown, and emergency procedures in accordance with the requirements of Rules 10A NCAC 15.1603(a), .0805, .0806 and .0513. Normal operating and emergency procedures shall be written and available to all radiation generating device operators and support staff. The registrant's operating and emergency procedures shall include instructions and procedures in at least the following:

(1) The handling, operation and use of radiation generating devices such that no individual is likely to be exposed to radiation doses in excess of the limits established in Rule 10A NCAC 15.1604 and .1611(a).

(2) Methods and occasions for conducting radiation surveys.

(3) Methods for controlling access to the radiographic vault.

(4) Personnel monitoring and the use of personnel monitoring equipment.

(5) Minimizing exposure of individuals in the event of an accident or equipment malfunction.

(6) The procedure for notifying proper personnel in the event of an accident or radiation related incident.

(7) Maintenance of radiation protection program records.

(8) The inspection and maintenance and operability checks of radiographic exposure devices, and survey instruments, transport containers, and storage containers.

(9) Steps that shall be taken immediately by radiography personnel in the event an electronic pocket dosimeter is found to be off scale or an alarm ratemeter alarms unexpectedly.

(10) Procedure for the operation of the X-ray system in accordance with manufacturer recommendations. No individual shall be permitted to operate RGDs in any manner other than that specified in the registrant’s or manufacturer operating procedures unless the person has obtained written approval of the individual responsible for radiation or the Radiation Safety Officer (RSO).

(11) No individual shall bypass a safety device unless the person has obtained the written approval of the person responsible for radiation safety or the RSO.

(12) Safety devices including interlocks, shutters, and warning lights shall be tested for proper operation at the beginning of each day prior to use.

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(13) No person shall be permitted to operate or maintain RGDs unless the person has received training and instruction in the X-ray equipment operating and emergency procedures for the RGD and instruction that is in accordance with Rule 10A NCAC 15.1003.

Access Control Procedures: Restrict access to areas where X-ray equipment is used to authorized personnel only.

5. **Emergency Preparedness**

Emergency Procedures: Establish emergency procedures commensurate with the health and safety risks of the radiological operations and train personnel on emergency procedures for incidents involving radiation exposure or equipment malfunction. Emergency procedures of radiation emergencies should be developed in coordination with the registrant's Emergency Action Plans (EAP) required by OSHA 29 CFR § 1910.38 Emergency action plans.

Incident Reporting: Implement a system for reporting and investigating radiation incidents and near-misses to prevent future occurrences. Policies and procedures for reporting radiation related incidents should be commensurate with the provisions of Rule 10A NCAC 15.1645 - .1647.

6. **Documentation and Recordkeeping**

Regulatory Compliance: Keep records of all training, maintenance, calibration, and radiation monitoring activities to demonstrate compliance with regulatory requirements. Accurate records of radiation exposure, surveys, and program implementation must be maintained.

Recordkeeping Requirements
The registrant shall maintain, for a minimum period of three years after the record is made, the following records for inspection by the regulating agency (NCRPS):

A. **Requirements for Radiation Protection Program Records, Reports and Notifications**
Recordkeeping requirements relating to the radiation protection program documentation, audit and annual reviews are provided in Rule 10A NCAC 15.1636. These records must be maintained by the registrant for review by the regulating agency until the registration is terminated.

Records of this technical plan review and shielding design assessment and post installation radiation surveys shall be maintained in accordance with the requirements of 10A NCAC 15.0603(b) and 10A NCAC 15.0603(c). Other general radiation protection program records and recordkeeping requirements of the NC Regulations are enumerated under Rules 10A NCAC 15.0115, 10A NCAC 15.1635, 10A NCAC 15.1636, 10A NCAC 15.1637, 10A NCAC 15.1638, 10A NCAC 15.1639, 10A NCAC 15.1640, 10A NCAC 15.1641, 10A NCAC 15.1642, and 10A NCAC 15.1644.

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B. Reports and notification of incidents requirements may be reviewed under Rules 10A NCAC 15 .1645, 10A NCAC 15 .1646, 10A NCAC 15 .1647, and 10A NCAC 15 .1649.

C. **Industrial Radiography Records**

1. Copies of the registration issued by the regulating agency (NCRPS), including the complete application for registration submitted for the registration that includes all amendments; and current operating and emergency procedures.

2. **Utilization Logs:** Current utilization logs must be maintained for inspection by the regulating agency (NCRPS) at the address specified in the registration, showing for each radiation generating device the information required by Rule 10A NCAC 15.0523(a)(6). In accordance with Rule 10A NCAC 15.0509, records of X-ray system utilization logs shall be maintained for regulatory agency review, showing a description of each radiation generating device that includes equipment identification information such as the make, model number, and serial number, the identity and signature of the radiographer to whom the equipment is assigned, the site where used and dates of use.

3. Records of inspection and maintenance of X-ray system. The record shall include the date of the check, name of the individual performing the check, equipment involved, any problems found in daily checks and quarterly inspections; and any repairs or maintenance made and name of individual or company performing the repair.

4. Records of vault alarm system tests.

5. Records of the training and certification of each radiographer and radiographer's assistant including:

    a. Radiographer certification documents and verification of certification status.

    b. Records of initial training, copies of written tests; dates and results of oral tests and field examinations; and names of individuals conducting and receiving the oral test or field examination.

    c. Records of periodic training and semi-annual inspections of job performance, list of topics discussed; date(s) of the review; and names of the instructors and the attendees.

    d. Records of inspections of job performance, the records shall also include a list showing the items checked and any noncompliance observed by the Radiation Safety Officer.

6. Records for pocket dosimeters to include daily exposure readings and yearly operability checks.

7. Records of dosimetry reports received from the accredited National Voluntary Laboratory Accreditation Program (NVLAP) personnel dosimetry processor. These records, as well as any records of exposure estimates required as a result of off-scale direct reading dosimeters, or lost or damaged personnel dosimeters, shall be maintained until the agency terminates the license or registration or until authorized by the regulating agency (NCRPS).

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8. Records of radiographic vault surveys performed prior to entering the radiographic vault after radiographic exposures.
9. Records of area surveys required by Rule 10A NCAC 15.0515.
10. Records of facility plans review, technical reviews, shielding assessments or equipment modifications must be maintained on file for review.
11. The registrant shall notify the regulating agency in writing when any change will render the information contained in the original application for registration or current notice of registration no longer accurate. Records of changes or modifications to the facility design or registered equipment must be maintained on file for review by the regulating agency.
12. Changes in the facility or registered equipment must be reported and submitted to the regulating agency for review in accordance with the provisions of 10A NCAC 15.0209.
13. Copies of current operating and emergency procedures until the regulating agency (NCRPS) terminates the registration and copies of superseded material shall be retained for three years after the change is made.
14. Records of the latest calibrations of operability checks of pocket dosimeters or electronic personal dosimeters.

Each record required by Rule 10A NCAC 15.0523 - Records Of Industrial Radiography shall be legible throughout the specified retention period. The record may be an original, a reproduced copy or microform provided that the copy or microform is authenticated by the licensee and the microform is capable of reproducing a clear copy throughout the required record retention period. The record may also be stored in electronic media with the capability for producing legible, accurate and complete records during the required record retention period. Records, such as letters, drawings and specifications shall include all pertinent information, such as stamps, initials and signatures. The licensee or registrant shall maintain safeguards against tampering with and loss of records.

Implementing these policies and procedures helps ensure a safe working environment while preserving the integrity of the art pieces being examined.

ALARA Program: The program should incorporate procedures and engineering controls to ensure that occupational doses and doses to the public are kept As Low As Reasonably Achievable (ALARA). The registrant shall use procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public and releases of radioactive materials in effluents to unrestricted areas that are as low as is reasonably achievable (ALARA).

Annual Reviews and Program Audits: The registrant shall annually review the radiation protection program content and implementation and make necessary changes to ensure that the program

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documentation remains current and is commensurate with the implementation of the operational radiation safety program.

Dosimetry Program: The radiation protection program must include a dosimetry program in accordance with Rule 10A NCAC 15.1614(1) to ensure compliance with dose limits for radiation workers and the general public. registrant shall monitor exposures to radiation and radioactive material at levels sufficient to demonstrate compliance with the occupational dose limits of 10A NCAC 15, Section .1600. As a minimum requirement The registrant shall monitor occupational exposure to radiation and shall supply and require the use of individual monitoring devices by:

Adults likely to receive, in one year from sources external to the body, a dose in excess of 10 percent of the limits in Rule .1604(a) of this Section;

Minors likely to receive, in one year, from sources of radiation, a deep dose equivalent in excess of 0.1 rem (1 mSv), a lens dose equivalent in excess of 0.15 rem (1.5 mSv), or a shallow dose equivalent in excess of 0.5 rem (5 mSv).

Declared pregnant women likely to receive, during the entire pregnancy, from sources of radiation external to the body, a deep dose equivalent in excess of 0.1 rem (1 mSv).

Individuals entering a high or very high radiation area.

External Radiation Monitoring and Surveys: Regular personnel monitoring and surveys of radiation levels in restricted and unrestricted areas must be conducted to ensure compliance with the dose limit requirements for occupational and member of the public radiation dose limits as enumerated in Rules 10A NCAC 15.1604 and .1611(a) respectively. Rule **10A NCAC 15.1612 - Compliance With Dose Limits For Members Of The Public** requires the registrant to make or cause to be made, as appropriate, surveys of radiation field intensity levels in unrestricted and controlled areas to demonstrate compliance with the dose limits for individual members of the public in Rule 10A NCAC 15.1611(a).

The registrant must demonstrate compliance with the annual dose limit in Rule 10A NCAC 15.1611(a) through demonstrating by measurement or calculation that the total effective dose equivalent to the individual likely to receive the highest dose from the registered operation does not exceed the annual dose limit; or by demonstrating that if an individual were continually present in an unrestricted area, the dose from external sources of radiation would not exceed 0.002 rem (0.02 mSv) in an hour and 0.05 rem (0.5 mSv) in a year.

Training: Personnel must be adequately trained in radiation protection principles and practices.

Each of the primary RPP primary elements is described in the section below:

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Radiation Survey Requirements

No radiographic operation shall be conducted unless calibrated and operable radiation survey instrumentation as described in Rule 10A NCAC 15.0506 is available and used where radiography is performed. A survey with a radiation detection instrument shall be made after each radiographic exposure to determine that the radiation source is off. Records of surveys required by this Rule shall be maintained in accordance with the requirements of Rule 10A NCAC 15 .0523.

Surveys shall be performed with a radiation survey instrument capable of measuring the radiation energies of the system surveyed; confirming that the applicable radiation dose limits are met; and calibrated according to the manufacture's recommended frequency or at least annually when a frequency is not recommended.

In addition to the radiation surveys required for radiography vault operations appropriate radiation surveys as set forth in Rule 10A NCAC 15.1613(a) and (b) shall be conducted that are sufficient to demonstrate compliance with the provisions of Rule 10A NCAC 15.0804(a) such that the surveys are in accordance with the following circumstances:

1. Within 30 days after initial operation of a radiation generating device.
2. Prior to use following any change in the initial arrangement, including the number or type of local components in the system.
3. Prior to use following any maintenance requiring the disassembly or removal of a local component in the system that could affect the radiation exposure to personnel.

Posting of Controlled and Restricted Access Areas

Controlled and Restricted Access Areas shall be designated for the proposed radiography vault where all radiographic procedures will be performed. The protective barriers enclosing the X-ray system represent the boundary of the **Controlled Area** including the ceiling and floor as designated on the site drawing in **Appendix A**.

Individuals must be warned of **Controlled** or **Restricted Areas** containing ionizing radiation sources through appropriate signs, labels or other warning systems placed at the entrances into these areas. Radiation warning signs shall be posted on the access door to the radiography vault in accordance with the requirements of10A NCAC 15 .0804(c). Each area of use or room containing RGDs shall be conspicuously posted with caution signs in accordance with the requirements of Rule 10A NCAC 15.1623, bearing the radiation caution symbol and the words "**CAUTION - X-RAY EQUIPMENT – HIGH RADIATION AREA**," or words having a similar meaning. The warning sign shall be in accordance with the requirements of 10A NCAC 15.1623, 10A NCAC 15.1624. An example of appropriate warning signage is provided below.

The access door for the Controlled / Restricted Area (radiography vault) shall be posted with a High Radiation Area warning sign as shown below or one that meets the requirements of Rule 10A NCAC 15.1623 and .1624(b) or signage with similar meaning.

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Figure 15. High Radiation Area Warning Sign

Restricted Access Areas
Restricted Access Areas are designated boundary areas within the Controlled Area where X-ray equipment operators or ancillary staff may not enter during radiographic operations. The equipment operator must ensure that only authorized individuals are allowed into the radiography vault during times that the X-ray system is energized. The **Controlled Area** must be cleared of all personnel during radiographic procedures.

Control Of Access To High Radiation Areas
Control of access to High Radiation Areas inside the radiography vault must be in accordance with 10A NCAC 15.1615. The registrant must ensure that the entrance or access point to the vault enclosure which is classified as a high radiation area when the X-ray system is operated, has installed at least one of the following features:

(A) A control device that, upon entry into the area, causes the level of radiation to be reduced below that level at which an individual might receive a deep-dose equivalent of 0.1 rem (1 mSv) in one hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

(B) A control device that energizes a conspicuous visible or audible alarm signal so that the individual entering the high radiation area and the supervisor of the activity are made aware of the entry.

(C) Entryways that are manually locked may be utilized, except during periods when access to or egress from the radiography vault is required, with positive control over each individual entry. **OSHA 29 CFR § 1910.36(d)(1)** requires that "**employees must be able to open an exit route door from the inside at all times without keys, tools, or special knowledge. A device such as a panic bar that locks only from the outside is permitted on exit discharge doors**."

Normal (Standard) Operating and Emergency Procedures
Written safety and operating procedures must developed and documented and be made available for reference in the X-ray control room to X-ray system operators and ancillary staff. X-ray system User/Operations manuals must be made available at the X-ray control station for reference by operators/radiographers.

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Security Of Radiation Sources
The X-ray system and radiography vault shall be secured when not in use in accordance with the requirements of **10A NCAC 15.1622 - Security of Sources of Radiation**. Control of ionizing radiation sources against unauthorized access, use or removal when the system is not in use, stored or not under the direct surveillance of the operator; means that access to the radiography vault containing the X-ray system should be restricted by the use of locked doors.

User access should be restricted at the workstation or X-ray controls by locking out the X-ray system power source, control panel and generator with keyed locks that may be used to lock and unlock the X-ray control system, and user passwords that restrict user authorization for X-ray system workstations. The following security requirements must be enforced by the registrant:

(a) The registrant shall secure from unauthorized access, use or removal the proposed X-ray system when not in use and stored in controlled area of the radiography vault.

(b) The registrant shall control and maintain constant surveillance of the proposed X-ray system while in use in the radiography vault.

(c) The registrant shall control entry into the restricted area of the radiography vault during radiographic operations.

Reporting Requirements

Reports of Changes to Registration
A report must be filed with the NC Radiation Protection Section to change the equipment information on the current Notice of Registration in accordance with the requirements of 10A NCAC 15 .0209. The required forms to add / delete equipment may be accessed at:

http://www.ncradiation.net/Xray/documents/RegForm_HlgArt.pdf

http://www.ncradiation.net/Xray/documents/RegForm_DeleteXrayEquip.pdf

Training Requirements

A. Radiation Safety Officers (RSO) Training and Experience

Radiation Safety Officers (RSO) for permanent industrial radiography installations must meet the requirements of 10 CFR § 34.42 - Radiation Safety Officer for Industrial Radiography. The RSO shall ensure that radiation safety activities are being performed in accordance with approved procedures and regulatory requirements in the daily operation of the licensee's program. The minimum qualifications, training, and experience for RSOs for industrial radiography operations are as follows:

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(1) Completion of the training and testing requirements of § 34.43(a);

(2) 2000 hours of hands-on experience as a qualified radiographer in industrial radiographic operations; and

(3) Formal training in the establishment and maintenance of a radiation protection program.

(b) The NC Radiation Protection Section (NCRPS) will consider alternatives when the RSO has appropriate training and/or experience in the field of ionizing radiation, and in addition, has adequate formal training with respect to the establishment and maintenance of a radiation safety protection program. Generally, the NCRPS will accept the training and experience requirements of the American Society of Nondestructive Testing (ASNT) Industrial Radiography Radiation Safety Personnel (IRRSP) for X-ray radiography found under Part I – ASNT IRRSP Qualification and Certification Requirements, Section 2.3 as described below:

a. **Training:** Forty (40) hours of formal classroom instruction in the radiation safety topics described in the Suggested State Regulations for Control of Radiation (SSRCR) Part E, ¶ E.17(g) for X-ray only. As an alternative the NCRPS may accept twenty-eight (28) hours of web-based training combined with twelve (12) hours of classroom or laboratory training covering the hands-on portion of the training may be used. The hands-on training shall include, but not be limited to, the use, operation, calibration, and limitations of radiation survey instruments; survey techniques; and use of personnel monitoring equipment.

b. **Experience**: A minimum of one hundred sixty (160) hours of active participation in performing X-ray radiography for X-ray only certification.

The specific duties and authorities of the RSO include, but may not limited to:

(1) Establishing and overseeing all operating, emergency, and ALARA procedures as required by 10 CFR part 20 of this chapter, and reviewing them regularly to ensure that the procedures in use conform to current 10 CFR part 20 procedures, conform to other NRC regulations and to the license conditions.

(2) Overseeing and approving all phases of the training program for radiographic personnel, ensuring that appropriate and effective radiation protection practices are taught;

(3) Ensuring that required radiation surveys and leak tests are performed and documented in accordance with the regulations, including any corrective measures when levels of radiation exceed established limits;

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(4) Ensuring that personnel monitoring devices are calibrated and used properly by occupationally exposed personnel, that records are kept of the monitoring results, and that timely notifications are made as required by § 20.2203 of this chapter; and

(5) Ensuring that operations are conducted safely and to assume control for instituting corrective actions including stopping of operations when necessary.

B. Radiographer Certification

Radiographer certification shall be in accordance with the provisions of 10A NCAC 15.0525 - Radiographer Certification. Radiographers shall be certified by an independent certifying organization such as the American Society of Nondestructive Testing (ASNT), International Committee for Nondestructive Testing (ICNDT):or other society or association, whose members participate in, or have an interest in, the field of industrial radiography.

Radiographer certification programs shall require applicants for certification to receive training in the topics set forth in Rule 10A NCAC 15.0519 and satisfactorily complete a written examination covering the topics in Rule 10A NCAC 15.0519 and require applicants for certification to provide documentation that demonstrates that the applicant has received training in the topics set forth in Rule 10A NCAC 15.0519; or have satisfactorily completed a minimum period of on-the-job training; and received verification by an the NC Radiation Protection Section (NCRPS) that the applicant has demonstrated the capability of independently working as a radiographer.

Radiographer training shall be designed to test an individual's knowledge and understanding of the topics set forth in Rule 10A NCAC 15.0519 written in a multiple-choice format; and have test items drawn from a question list based on the material contained in Rule 10A NCAC 15.0519.

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VI. REFERENCES

Shielding Design References

NCRP Report No. 49 - Structural Shielding Design And Evaluation For Medical Use Of X Rays And Gamma Rays Of Energies Up To 10 MeV

This report offers guidelines for the structural shielding design and evaluation of medical installations using X-rays and gamma rays up to 10 MeV. It provides technical information on selecting appropriate shielding materials and calculating barrier thicknesses to ensure safety in medical facilities.

NCRP Report No. 147 - Structural Shielding Design for Medical X-Ray Imaging Facilities

This report provides recommendations and technical information related to the design and installation of structural shielding for facilities that use X-rays for medical imaging. It includes discussions on shielding materials, barrier thickness calculations, and shielding design goals for controlled and uncontrolled areas.

NCRP Report No. 151 - Structural Shielding Design and Evaluation for Megavoltage X- and Gamma-Ray Radiotherapy Facilities

This report provides recommendations and technical information related to the design and installation of structural shielding for facilities using megavoltage X-rays and gamma rays for radiotherapy. It includes guidelines for shielding materials, barrier thickness calculations, and design goals for protecting workers and the public. This report supersedes the recommendations in NCRP Report No. 49 for such facilities.

Regulatory References

North Carolina Regulations (10A NCAC 15 – Radiation Protection): Ensure compliance with applicable rules of Sections .0100, .0200, .0500, .0800, .1000, and .1600 as described in this report. Please refer to the noted sections of the North Carolina Regulations for Protection Against Radiation for more detailed information on specific regulatory requirements.

FDA Regulations 21 CFR 1020.40 – Performance Standards for Cabinet X-ray Systems:

NRC Regulations: Follow guidelines set by the Nuclear Regulatory Commission (NRC) for radiation safety in industrial radiography included in **10 CFR Parts § 20 and § 34**.

OSHA Standards: Comply with Occupational Safety and Health Administration (OSHA) standards for radiation protection included in **29 CFR § 1910.1096** Ionizing radiation.

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VII. DEFINITIONS

The following definitions apply to certain terms used in this Report.

Absorbed Dose: The mean energy imparted to matter by ionizing radiation per unit mass of matter. The special unit of absorbed dose is the rad. One rad equals 10^{-2} joule per kilogram (100 ergs per gram).

Attenuation: The reduction of intensity (exposure rate) upon passage of radiation through a material. This report is concerned with broad beam attenuation, under conditions where the field area is large at the barrier and the point of measurement is near the exit surface (< 30 cm).

Collimator: Means a radiation shield that is placed on the end of the guide tube or directly onto a radiographic exposure device or X-ray tube housing to limit the size, shape, and direction of the primary radiation beam to perform a radiographic exposure.

Concrete Equivalence: Refers to the comparison of the shielding effectiveness of concrete to that of other materials, such as lead or steel. This concept is used to determine the thickness of concrete required to provide the same level of radiation protection as a given thickness of another material.

Control Panel: Means that part of the X-ray system controls upon which are mounted the switches, knobs, pushbuttons, and other hardware necessary for manually setting the radiographic technique factors.

Constant Potential: Unidirectional potential (or voltage) which has little, or no, peridic variation.

Controlled Area: A defined area in which the exposure of individuals to radiation is under the supervision of the designated Radiation Safety Officer (RSO) or their authorized designee. This implies that a controlled area is one that requires control of access, occupancy and working conditions for radiation protection purposes.

Diagnostic-Type Protective Tube Housing: An X-ray tube housing so constructed that the leakage radiation measured at a distance of 1 meter from the source cannot exceed 100 mR in 1 hour when the tube is operated at its maximum continuous rated current for the maximum rated tube potential.

Dose Equivalent *(H):* A quantity used for radiation protection purposes that expresses on a common scale for all radiations the irradiation incurred by exposed persons. It is defined as the product of the absorbed dose in rads and specific weighting factors. The special unit of dose

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equivalent is the rem. For radiation protection purposes of this Report, the dose equivalent in rems may be considered numerically equivalent to the absorbed dose in rads and the exposure in roentgens (R) since the weighting factor for X-ray photons is 1.

Dose Rate: Means the radiation dose per unit time.

Door means an entry point into a secondary protective barrier which is designed to be movable or opened for routine operational purposes, that does not generally require special tools to open, and permits access to the interior of the radiography vault.

Enclosed Beam RGD: Means an RGD with all possible x-ray beam paths contained in a chamber, coupled chambers, or other beam-path-confinement devices to prevent any part of the body from intercepting the beam during normal operations. Normal access to the primary beam path, such as a sample chamber door, shall be interlocked with the high voltage of the x-ray tube or the shutter for the beam to be considered "enclosed." An open-beam device placed in an interlocked enclosure is considered an "enclosed beam" unless there are provisions for routine bypassing of the interlocks.

Exposure: A measure of X or gamma radiation based upon the ionization produced in air by X or gamma rays. The special unit of exposure is the roentgen (R). For radiation protection purposes of this Report, the number of roentgens may be considered to be numerically equivalent to the number of rads or rems.

Exposure Rate: The radiation exposure per unit time as measured by radiation measurement instrumentation.

External Surface means the outside surface of the radiography vault enclosing protective barriers, including the door, access panels, ventilating ducts, electrical boxes, conduits, and other permanently mounted hardware and including the plane across any aperture in primary or secondary protective barriers.

Fail-Safe Characteristics: Means a design feature that causes the radiation beam to terminate, port shutters to close, or otherwise prevents emergence of the primary beam, upon the failure of a safety or warning device. For example, if an "X-ray On" light indicator or shutter indicator or interlock fails, the radiation beam shall terminate.

Half-Value Layer (HVL)***:*** Thickness of a specified material which, when introduced into the path of a given beam of radiation, reduces the exposure rate by one-half.

High Radiation Area: Means an area, accessible to individuals, in which radiation levels from sources external to the body could result in an individual receiving a dose equivalent in excess of

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0.1 rem (1 mSv) in one hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

Interlock: A device which automatically causes a reduction or termination of the radiation field exposure rate upon entry by personnel into a **High Radiation Area**. Alternatively, an interlock may prevent entry into a High Radiation Area.

Kilovolt (kV): A unit of electrical potential difference equal to 1000 volts.

Kilovolt Constant Potential: The potential difference in kilovolts of a constant potential generator.

Kilovolt Peak: The crest value in kilovolts of the potential difference of a pulsating potential generator. When only one-half of the wave is used, the value refers to the useful half of the cycle.

Kilovolt Peak Potential: Refers to the peak voltage applied across an X-ray tube during the production of X-rays. This voltage accelerates electrons from the cathode to the anode, resulting in the generation of X-ray photons. The kVp determines both the quantity and quality of the X-rays produced, influencing the maximum energy of the photons and the overall penetration power of the X-ray beam.

Lead Equivalence: The thickness of lead affording the same attenuation, under specified conditions, as the material in question.

Lead Equivalent Shielding Capacity (LESC): Refers to the measure of a material's ability to attenuate ionizing radiation, expressed in terms of the thickness of lead that provides the same level of radiation attenuation. This concept is used to compare the effectiveness of different shielding materials by equating their protective capabilities to that of lead at specific energies. For example, a material with a lead equivalent of 0.5 mm provides the same radiation shielding as a 0.5 mm thick layer of lead at a given X-ray beam energy.

Leakage Radiation: Leakage radiation refers to radiation that escapes from the shielded housing of an X-ray tube or other radiation-emitting device, excluding the primary or useful beam. This type of radiation is incidental to the primary beam radiation produced when the device is activated but is not part of the intended radiographic process. Regulations typically limit the amount of leakage radiation to ensure safety. For example, in diagnostic X-ray systems, leakage radiation is restricted to a maximum of 1 milligray per hour (mGy/hr) at a distance of 1 meter from the source.

Leakage Technique Factors: Means the technique factors associated with the X-ray system source assembly (i.e., tube housing and beam limiting device) which are used in measuring leakage radiation.

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Milliroentgen (mR): One-thousandth of a roentgen (R).

Noncontrolled Area: Any space in a radiological facility not meeting the definition of controlled area. Generally, uncontrolled areas are also designated as unrestricted areas where the allowable radiation field intensity may range from local natural baclground levels to no greater than 2 mrem/h as a time weighted averge (TWA) of an 8, 10 or 12 hour period.

Occupancy Factor (T): Refers to the average fraction of time that a specific area that is adjacent to an ionizing radiation source is occupied by an individual who is maximally exposed to radiation while the radiation source is active. This factor is crucial in determining the necessary shielding and safety measures to ensure that radiation exposure remains within acceptable limits for both radiation workers and members of the the public.

Occupational Exposure: The exposure of an individual to ionizing radiation in the course of employment in which the individual's normal duties or authorized activities necessarily involve the likelihood of exposure to ionizing radiation.

Occupiable Area: Any room or area, indoors or outdoors, that is likely to be occupied by any individual, either regularly or periodically during the course of work, habitation or recreation and in which an ionizing radiation field exists because of radiation sources in the vicinity.

Permanent Radiographic Installation: Refers to a radiation generating device (RGD) utilized in an enclosed shielded room, cell, or vault that allows entry by authorized individuals when the RGD is not energized.

Primary X-Ray Beam: Refers to radiation that passes through an aperture that causes the collimation of the radiation field through the source assembly housing by a direct path from the radiation source.

Primary Protective Barrier: A primary protective barrier in radiation protection is a structure designed to intercept and attenuate the primary radiation beam emitted directly from a radiation source, such as an X-ray tube. This barrier is essential in shielding areas occupied by individuals from direct exposure to high levels of radiation transmitted through the barrier. Examples of primary protective barriers include walls, floors, and ceilings that are specifically constructed to absorb and reduce the intensity of the primary radiation to unrestricted area levels.

Qualified Expert: With reference to radiation protection**,** a person having the knowledge and training to advise regarding radiation protection needs, to measure ionizing radiation, and to evaluate safety techniques (for example, persons having relevant degrees in physics or engineering, or certification from the American Board of Radiology or American Board of Health Physics, or

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those having equivalent qualifications). With reference to shielding design**,** a person having particular knowledge and training in the field of radiation shielding.

Rad: A special unit of absorbed dose equal to 100 ergs/gram or 0.01 Joule/kilogram (0.01 Gray).

Radiation Area: Means an area, accessible to individuals, in which radiation field intensity levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 mSv) in one hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

Radiation Safety Officer: Means an individual designated by a licensee or registrant who has the training, experience knowledge and responsibility to apply appropriate radiation protection rules regarding the day to day management, oversight and implementation of the radiation protection program.

Rem: The special unit of radiation quantities expressed as dose equivalent. The dose equivalent in rems is equal to the absorbed dose in rads multiplied by the quality factor (1 rem = 0.01 sievert). As used in this Report, the quality factors for converting absorbed dose to dose equivalent. For X-ray or gamma ray photons the quality factor is equal to 1.

Restricted Area: Means an area, access to which is controlled by a licensee or registrant for purposes of protecting individuals against undue risks from exposure to radiation and radioactive materials. Restricted area does not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area.

Roentgen (R): A special unit of ionizing radiation exposure equal to 2.58×10^{-4} Coulombs/kilogram of air.

Scattered Radiation: Radiation that, during passage through matter, has been deviated in direction. (It may have been modified also by a decrease in energy.)

Secondary Protective Barrier: A secondary protective barrier in radiation protection is designed to intercept and attenuate incidental radiation fields, which includes both leakage radiation from the radiation source and scattered radiation from objects or other barriers. Unlike primary protective barriers, which deal with the direct beam, secondary barriers protect against radiation that has been deflected or leaked. These barriers are essential for ensuring that areas adjacent to or near the radiation source remain safe for occupancy.

Secondary Radiation: The sum of leakage and scattered radiation.

Sievert: The SI unit of any of the quantities expressed as dose equivalent. The dose equivalent in sieverts is equal to the absorbed dose in grays multiplied by the quality factor (1 Sv = 100 rems).

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Source-Surface Distance (SSD): The distance, measured along the central ray, from the center of the front surface of the source X-ray focal spot to the surface of the irradiated target object.

Stationary RGD: Refers to radiation generating devices and equipment that is installed, constrained or restricted in a fixed location.

Tenth-Value Layer (TVL): Thickness of a specified material which, when introduced into the path of a given beam of radiation, reduces the exposure rate to one-tenth of it's unattenuated value.

Useful Beam: Radiation which passes through the window, aperture, cone or other collimating device of the source housing. Sometimes called "primary beam."

Use Factor (Beam Direction Factor) (U): Fraction of the beam "ON" time during which the radiation under consideration is directed at a particular barrier.

User: Any individual who personally utilizes or manipulates a source of radiation.

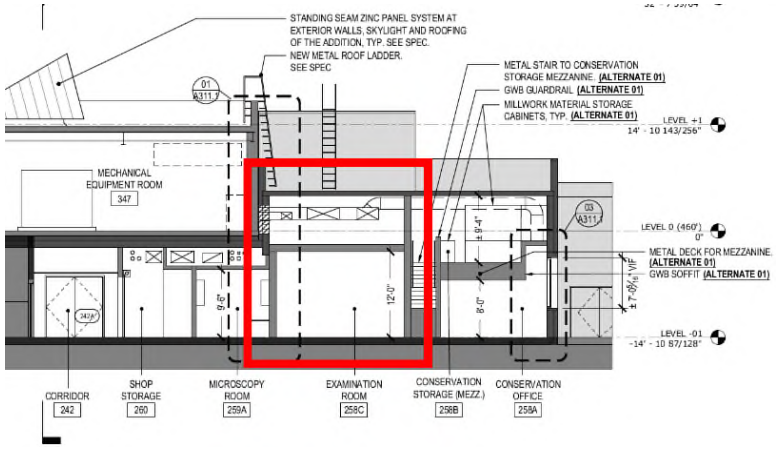
Workload (W): The degree of use of an X-ray or gamma-ray source. For X-ray equipment operating below 4 MV, the weekly workload is usually expressed in milliampere minutes per week (mA-min/wk.).

X-ray Generator: Refers to the part of an x-ray system that provides the accelerating (high) voltage and current for the X-ray tube.

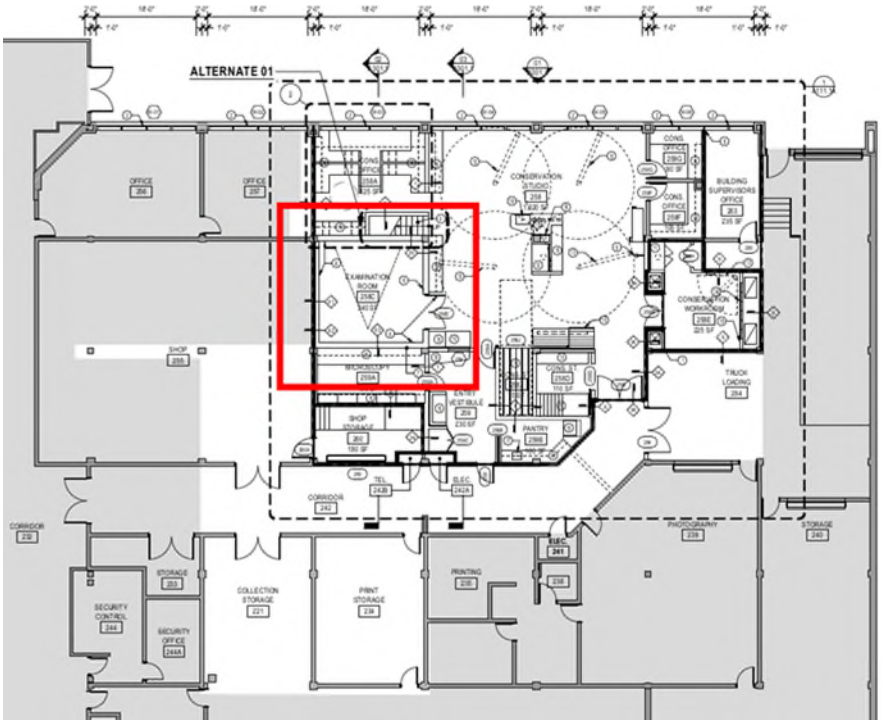
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Appendix A

Archetectural Drawings



Elevation View of Radiography Vault Roof, Plenum and Facility Roof



View of Radiography Vault and Adjacent Occupied Areas

Carolina Safety & Health Consultants, LLC

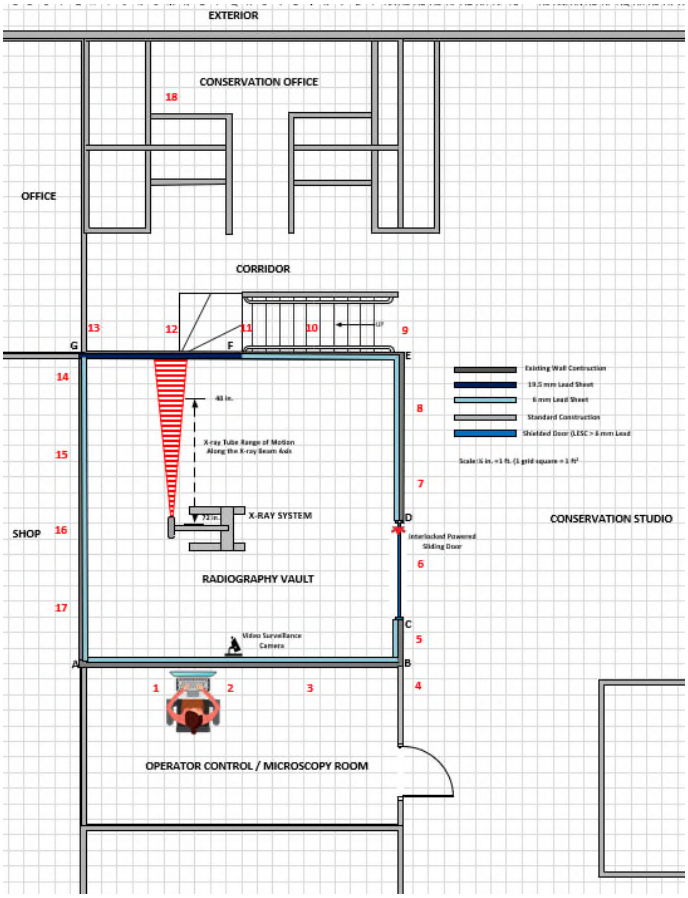
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Appendix B

Radiography Vault Shielding Design Site Drawing

Scale: 0.25 inches = 1 foot – 1 grid square = 1 ft^2



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EXHIBITS

Docusign Envelope ID: A708AC2D-32EE-419A-BBBD-70DD021DD26A

SECTION 210210 – FIRE SUPPRESSION SUMMARY OF WORK

Engineer of Record for fire suppression work is Kevin R. Allen, PE, Salas O'Brien North Carolina, Inc., 702 Oberlin Road, Suite 300, Raleigh, NC 27605 (919) 832-8118. Fire suppression work shall be defined by drawings numbered with the prefix "FP", the general provisions of the Contract including General Conditions and Supplementary Conditions, Division 1 Specifications sections, and Division 21 Technical Specifications listed below. In addition, fire suppression work may be defined by reference to other documents from any of the above-named sources as well as by project addenda.



06/30/2025

DIVISION 21 - FIRE SUPPRESSION

Section	Title
210210	Fire Suppression Summary of Work
210510	Fire Suppression Basic Requirements
210517	Sleeves and Sleeve Seals for Fire Suppression Piping
210521	Fire Suppression Piping Specialties
210529	Fire Suppression Piping Hangers and Supports
210553	Fire Suppression Painting and Identification
211000	Sprinkler and Standpipe Fire Suppression Systems
212400	Dry Chemical Fire Suppression System

END OF SECTION 210210

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SECTION 210510 – FIRE SUPPRESSION BASIC REQUIREMENTS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

The requirements specified herein shall govern all Sections in Division 21, whether stated therein or not.

Where items specified in the various sections of this Division conflict with requirements of this Section, the former shall govern.

SUBMITTALS

Specific submittal requirements are defined in each section of this Division.

Welders' and Brazers' Qualifications: Operators who are to do the welding and/or brazing must be properly qualified to do satisfactory work. **Proof of an operator's qualifications shall be either the Contractor's record of suitable tests passed within the preceding six months while in the employ of the Contractor, or tests made before the start of work.** Submit qualification data for each operator prior to their starting work. Any workman considered by the A-E as not having the skill necessary for the work shall be required to pass an appropriate qualification test or shall be at once barred from further welding and/or brazing on the project.

EQUIPMENT SELECTION

The pump heads scheduled are for estimating purposes and are based on the individual equipment losses as scheduled. If the Contractor proposes using equipment, including control valves, that will increase the pump heads and/or fan static pressures, any required pump or fan changes, along with associated power wiring changes, shall be at the Contractor's expense.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END SECTION 210510

SECTION 210517 - SLEEVES AND SLEEVE SEALS FOR FIRE SUPPRESSION PIPING

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data, including installation instructions for each type of sleeve and sleeve seal product. Submit expansion compensation schedule showing Manufacturer's figure number, size, location, and features for each required expansion compensation product.

PART 2 - PRODUCTS

SLEEVES

Cast-Iron Pipe: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

Galvanized-Steel Pipe: ASTM A 53, Schedule 40, with plain ends and welded steel collar; zinc coated.

Galvanized Sheet Metal: Factory-fabricated of G90 galvanized sheet metal with lock-type longitudinal seam, minimum 18 ga.

SLEEVE-SEAL SYSTEMS

Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

Pressure Plates: Stainless steel.

Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

GROUT

Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

Characteristics: Nonshrink; recommended for interior and exterior applications.

Design Mix: 5000-psi, 28-day compressive strength.

Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

SLEEVE AND SLEEVE-SEAL APPLICATIONS

Use sleeves and sleeve seals for the following piping-penetration applications:

Penetration Application	Sleeve Type	Sleeve-Seal Required
Exterior walls above grade	Cast Iron	Yes
Exterior walls below grade	Cast Iron	Yes
Concrete slab on grade	Cast Iron	Yes
Concrete slab above grade	Galvanized Steel Pipe	No
Interior partitions	Galvanized Steel Pipe or Galvanized Sheet Metal Sleeve	No

SLEEVE INSTALLATION

Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

Sleeves are not required for core-drilled holes. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

Cut sleeves to length for mounting flush with both surfaces.

Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

Install sleeves for pipes passing through interior partitions. Cut sleeves to length for mounting flush with both surfaces and install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.

For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 019913.

SLEEVE SEAL SYSTEM INSTALLATION

Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

SLEEVE-SEAL-FITTING INSTALLATION

Install sleeve-seal fittings in new walls and slabs as they are constructed.

Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

Secure nailing flanges to concrete forms.

Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 210517

SECTION 210521 – FIRE SUPPRESSION PIPING SPECIALTIES

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data, including installation instructions, and dimensioned drawings for each type of manufactured piping specialty.

PART 2 - PRODUCTS

PIPE ESCUTCHEONS AND FLOOR PLATES

Escutcheons: Provide pipe escutcheons with polished chrome finish as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any.

Pipe Escutcheons for Moist Areas: For waterproof floors and in areas where water and condensation can be expected to accumulate, provide brass escutcheons, one piece type with setscrew or split casting type with concealed hinge and setscrew.

Pipe Escutcheons for Dry Areas: Provide stamped steel escutcheons, one piece type with spring clip fasteners or split, hinged type with spring clip fasteners.

Floor Plates: Provide floor plates as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Floor plates shall be one-piece type for new piping and split-casing type for existing piping.

DIELECTRIC FITTINGS

Dielectric Unions: Steel female pipe thread and copper solder joint ends conforming to dimensional, strength, and pressure requirements of ASME B 16.39, Class 1. Steel parts shall be galvanized or plated. Union shall have a water-impervious insulation barrier capable of limiting galvanic current to one percent of the short-circuit current in a corresponding bimetallic joint. When dry, it shall also be able to withstand a 600-volt breakdown test.

Dielectric Flanges: Factory-fabricated companion-flange assembly rated for 150 psig or 300-psig as required by system operating pressure. Include flanges, full-face or ring-type neoprene or phenolic gasket, phenolic or polyethylene bold sleeves, phenolic washers, and steel bolts, backing washers, and nuts.

PRESSURE GAGES

General: Provide liquid filled pressure gages of materials, capacities, and ranges indicated, designed and constructed for use in fire protection service, UL Listed and FM approved.
Type: Fire protection ±3-2-3% of span, 1% accuracy, ASME B40.1 grade B, phosphor bronze bourdon type, bottom connection.

Case: Stainless steel with polycarbonate lens, 3-1/2" diameter.

Connector: Brass with 1/4" male NPT.

Dial: Black figures on white background.

Range: Conform to the following:

Water: 0 - 300 psi

Air: 0 – 80 psi retard to 250 psi

PRESSURE GAGE COCKS

General: Provide pressure gage cocks between pressure gages and gage tees on piping systems. Construct gage cock of brass with 1/4" female NPT on each end, and "T" handle brass plug.

Siphon: 1/4" straight coil constructed of brass tubing with 1/4" male NPT on each end.

Snubber: 1/4" brass bushing with corrosion resistant porous metal disc, through which pressure fluid is filtered. Select disc material for fluid served and pressure rating.

PART 3 - EXECUTION

INSTALLATION OF PIPING SPECIALTIES

Pipe Escutcheons and Floor Plates:

Install pipe escutcheons on each pipe penetration through floors, walls, partitions, and ceilings where penetration is exposed to view, and on exterior of building. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole, and is flush with adjoining surface.

Install floor plates on each pipe penetration through floors in unfinished areas, service and equipment areas, etc.

Dielectric Unions: Install at each piping joint between ferrous and non-ferrous piping. Comply with manufacturer's installation instructions.

INSTALLATION OF PRESSURE GAGES

General: Install pressure gages in piping tee with pressure gage cock, located on pipe at most readable position.

Pressure Gage Cocks: Install in piping tee with snubber. Install siphon for steam pressure gages.

Pressure Gage Connector Plugs: Install in piping tee where indicated, located on pipe at most readable position. Secure cap.

ADJUSTING AND CLEANING

Adjust faces of meters and gages to proper angle for best visibility.

Clean windows of meters and gages and factory-finished surfaces. Replace cracked or broken windows, repair any scratched or marred surfaces with manufacturer's touch-up paint.

END OF SECTION 210521

SECTION 210529 – FIRE SUPPRESSION PIPING HANGERS AND SUPPORTS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Testing Laboratory and FM Compliance: Provide products that are UL Listed or FM approved where required.

Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry, Inc. Standard Compliance: Comply with MSS SP-58 "Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation" for pipe hangers and supports.

NFPA Compliance: Comply with the requirements of the following, as applicable:

NFPA 13, *Chapter 9 – Hanging, Bracing and Restraint of System Piping*

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data, including installation instructions for each type of support and anchor. Provide spacing chart meeting NFPA 13 requirements.

PART 2 - PRODUCTS

GENERAL

Hangers and supports for fire suppression piping and equipment shall withstand five times the weight of the weight of the water filled pipe plus 250 lb at each point of piping support stresses within limits and under conditions indicated according to ASCE/SEI 7.

Design supports for multiple pipes, including floor stands, to be capable of supporting combined weight of supported systems and system contents.

Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

Structural support elements shall be fabricated from standard structural shapes complying with ASTM A 36 and/or from preformed channel struts.

Preformed channel struts shall be sized to meet section moduli requirements of NFPA 13. Strut shall be made from steel meeting the minimum mechanical properties of ASTM A653 SS, Grade 33, G90 galvanized. Fittings shall be manufactured from steel meeting the minimum requirements of ASTM A907 SS, Grade 33. All fittings and hardware shall be zinc plated in accordance with ASTM B633, SC3 for fittings and SC1 for threaded hardware. Channel members shall be "Unistrut", Allied Support Systems "Power Strut", or Cooper B-Line Systems, Inc. "Strut System", specifically sized in accordance with the criteria hereinbefore specified.

Building attachments for hangers and supports shall be as indicated on the Drawings. Where attachments are not indicated, they shall be as follows:

Attachment To	Attachment Method(s)
Concrete	Bolt to channel-type concrete inserts or utilize expansion anchors. Size concrete housekeeping pads so expansion anchors will be a minimum of 10 bolt diameters from the edge of the concrete base. Drill at locations and to depths that avoid reinforcing bars.
Solid Concrete Masonry Unit Walls	Use expansion anchors.
Hollow Walls	Bolt to slotted steel channels fastened to wall with expansion anchors.
Wood Structural Members	Install bolts through members.
Steel	Bolt hangers to MSS Type 19, 21, or 23 clamps on flanges of beams or on upper truss chords of bar joists. **To avoid stressing building steel structural elements, provide additional steel support members that span at least two beams or bar joists as required or as shown on the Drawings.** Attach additional steel support members via welding in accordance with AWS standards.

HORIZONTAL PIPING HANGERS AND SUPPORTS

Except as otherwise indicated, provide factory-fabricated adjustable steel clevis or swirl ring hangers complying with MSS SP-58, Type 1. Select size of hangers and supports to exactly fit pipe size for bare piping.

For exterior and wet/damp locations, hangers and rods are to be hot dipped galvanized.

VERTICAL PIPING CLAMPS

Provide factory-fabricated riser clamps complying with MSS Type 8 to support vertical piping systems. Select size of vertical piping clamps to exactly fit pipe size of bare pipe.

PART 3 - INSTALLATION

Install piping supports with maximum spacing and all-thread hanger rods sized in accordance with NFPA 13.

END OF SECTION 210529

SECTION 210553 – FIRE SUPPRESSION PAINTING AND IDENTIFICATION

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data and installation instructions.

PART 2 - PRODUCTS

PAINT FOR FERROUS SURFACES

Primer: 1 coat of fast drying, low VOC acrylic modified medium oil alkyd universal primer

Finish Paint: 2 coats of fast drying, low VOC alkyd gloss enamel

PLASTIC LABELS FOR EQUIPMENT

General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, minimum 2-1/2" X 3/4", 1/16" thick, engraved with engraver's standard letter style of black with white letter color, minimum 1/4" high, and punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

Fasteners: Self-tapping stainless steel screws.

Content for Equipment: Equipment's designation as show on Drawings or Owner's unique equipment number and additional information required by other Sections of Division 21. Contractor shall determine requirements prior to fabricating labels.

PIPE LABELS

Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1, except as hereinafter specified. Provide full-band pipe markers, extending 360 degrees around pipe at each location that attach without fasteners or adhesives.

Content: Provide minimum 1-1/4" high lettering to identify piping service using the same designations and abbreviations used on the Drawings. Include arrow indicating flow direction(s). Steam lines shall indicate pressure.

VALVE TAGS

Brass Valve Tags: Provide 0.032" thick polished brass valve tags, minimum 1-1/2" diameter, with stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener.
Valve Tag Fasteners: Provide solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes

required for proper attachment of tags to valves, and manufactured specifically for that purpose.

PART 3 - EXECUTION

PAINTING

Equipment specified in other sections of Division 21 to be provided with factory-applied finish painting shall not be field-painted. All finish painted equipment shall be touched up where factory paint is chipped, scratched, or otherwise damaged.

All equipment not factory finish painted shall be furnished in prime coat. All prime coated equipment shall be touched up where prime coats are chipped, scratched, or otherwise damaged. All prime coated equipment shall be thoroughly cleaned and left ready for finish painting.

All welds on piping shall be painted with one coat of primer. Miscellaneous black steel items such as hangers and rods, machinery supports, breechings and stacks, etc., that are not shop primed, shall be field painted with one coat of primer. All metal surfaces shall be thoroughly cleaned of rust and dirt and shall be degreased before application of primer.

Equipment and steel piping located in mechanical equipment rooms and spaces where equipment and piping is exposed to view shall be finish painted as specified above. Where indicated or specified, existing equipment, piping, etc., shall be cleaned and painted along with new work.

Exposed To View Non-Mechanical Spaces: Architect/Owner to select colors for finish painting.

Exposed To View Mechanical Spaces: If the Owner has an existing color schedule, the Contractor shall utilize these colors for all finish painting. Otherwise, finish colors shall be as follows:

Item	Label/Paint Color	Text Color	Identification
Piping	Bright Red	White	FS
Equipment	Bright Red	White	Refer to drawings
All Other	ANSI A13.1-2007		

EQUIPMENT IDENTIFICATION

Install plastic equipment label on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide labels for each of the following general categories of equipment and operational devices:

Main control and operating valves, including safety devices.

PIPING IDENTIFICATION

Provide pipe labels as follows wherever piping is exposed to view in finished spaces, in equipment rooms, in accessible maintenance spaces (shafts, tunnels, plenums), or concealed above lay-in ceilings. Label piping installed outdoors that is exposed to view.

Near each valve and control device.

Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch where there could be question of flow pattern.

Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
At access doors, manholes and similar access points which permit view of concealed piping.

Near major equipment items and other points of origination and termination.

Spaced at maximum spacing of 25' along each piping run.

VALVE IDENTIFICATION

Provide valve tag on every valve, cock and control device in each piping system; exclude check valves.

List each tagged valve in valve schedule for each piping system. Mount valve tag schedule in a frame with a glass cover in the primary mechanical room and include schedule(s) as part of the operating and maintenance data defined in Section 019913.

END OF SECTION 210553

SECTION 211000 – SPRINKLER AND STANDPIPE FIRE SUPPRESSION SYSTEMS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to this section.

QUALITY ASSURANCE

Installer Qualifications: Installation and alterations of fire suppression piping, equipment, specialties, and accessories, and repair and servicing of equipment shall be performed only by a qualified installer. The term qualified means experienced in such work (experienced shall mean having a minimum of 5 previous projects similar in size and scope to this project), familiar with all precautions required, and has complied with all the requirements of the authority having jurisdiction. Upon request, submit evidence of such qualifications to A/E.

NFPA Compliance: Comply with the requirements of the following, as applicable:

NFPA 13, *Standard for the Installation of Sprinkler Systems*

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*

NFPA 24, *Private Fire Service Mains*

NFPA 25, *Inspection, Testing and Maintenance of Water-Based Fire Suppression Systems*

NFPA 72, *National Fire Alarm Code*

NFPA 1961, *Standard for Fire Hose*

NFPA 1963, *Screw Threads and Gaskets for Fire Hose Connections*

Testing Laboratory and FM Compliance: Fire suppression system materials and components shall be Listed and Labeled, and Factory Mutual approved for the application anticipated.

North Carolina State Construction Office (SCO) Compliance: Comply with the SCO *Water Based Fire Protection Systems Guidelines and Policies,* dated April 30, 2020.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Include each type sprinkler head, valve, piping specialty, fire suppression specialty, fire department connection, hose and rack, and hose cabinet specified.

Shop Drawings: Submit drawings which have been prepared in accordance with NFPA 13 identified as "Working Plans," **including hydraulic calculations** for sprinkler systems, which have been approved by the authority having jurisdiction.

Hydraulic Calculations: For each sprinkler system, prepare and submit hydraulic calculations as outlined in NFPA 13, except that calculations shall be performed by computer using software intended specifically for fire protection system design using the design data shown on the Drawings and/or specified herein. **Software that uses k-factors for typical branch lines is not acceptable.** Calculations shall be based on the water supply data obtained by the Contractor from a certified flow testing agency to substantiate that the design area used in the calculations is the most demanding hydraulically. Provide a copy of the certified water flow test with the submittal package.

Provide a summary sheet listing sprinklers in the design area and their respective hydraulic reference points, elevations, actual discharge pressures and actual flows. Elevations of hydraulic reference points (nodes) shall be indicated. Documentation shall identify each pipe individually and the nodes connected thereto. Indicate the diameter, length, flow, velocity, friction loss, number and type fittings, total friction loss in the pipe, equivalent pipe length and Hazen-Williams coefficient for each pipe.

Provide a summary list for spare sprinklers per NFPA 13 requirements and include with submittal.

For gridded systems, calculations shall show peaking of demand area friction loss to verify that the hydraulically most demanding area is being used and a flow diagram indicating the quantity and direction of flows shall be included.

A drawing showing hydraulic reference points (nodes) and pipe designations used in the calculations shall be included and shall be independent of shop drawings.

State of North Carolina Shop Drawings Review: The A/E has primary responsibility for review and approval of fire suppression system shop drawings and hydraulic calculations and shall determine compliance with applicable codes and standards and the project contract documentation. However, after completing this review, the A/E will send one (1) copy of the shop drawings, including A/E review comments, to the State Construction Office (SCO) for additional review. Once all comments are resolved and approved by SCO, an approval letter from SCO releasing this part of project to enter into construction will be sent to the A/E.

Test Reports and Certificates: Include "Contractor's Material & Test Certificate for Aboveground Piping" and "Contractor's Material & Test Certificate for Underground Piping" as described in NFPA 13.

SYSTEM(S) DESCRIPTION

Provide water-based fire suppression systems as follows:

Fire suppression system is a "Wet-Pipe" system employing automatic sprinklers attached to a piping system containing water and connected to a water supply so that water discharges immediately from sprinklers opened by fire.

Water Supply Verification: Before beginning design and performing hydraulic calculations, the Contractor shall verify the water supply by test, using two (2) hydrants as close to the point of connection as possible. One hydrant shall be used for pressure testing while the second hydrant is used for flow testing. Contact the water supplier before testing to verify normal system status and to determine typical fluctuations in available pressure/flow at the connection location.

DESIGN CRITERIA AND PERFORMANCE REQUIREMENTS

Fire Protection design drawings issued by the A/E shall be considered as preliminary design documents that establish the performance requirements and design criteria for fire suppression sprinkler and/or standpipe systems. **Responsibility for design of fire suppression sprinkler and/or standpipe system(s), including comprehensive engineering analysis by a qualified professional engineer or a NICET Certified Level III technician, using performance requirements and design criteria hereinafter specified, is delegated to the Contractor.** When prepared in accordance with approved design standards by a professional engineer, documents shall be sealed and signed. Since NICET does not authorize seals or stamps for Technicians, documents prepared in accordance with approved design standards shall bear the signature, date, NICET certification title and number of the Technician taking responsibility for the work.

Base hydraulic design on 10 psi less static pressure, 10 psi less residual pressure, and 10% less residual flow than test results indicate.

Size piping to limit sprinkler system water flow velocity to 25 fps.

Exception: Limit water flow velocity to 18 fps for any segment with a vane-type waterflow switch, to comply with its UL listing.

Piping System and Component Working Pressure: Standard pressure sprinkler system components, listed for at least 175 psig.

Sprinkler Occupancy Hazard Classifications:

Building Service Areas: Ordinary Hazard, Group 1.

Electrical Equipment Rooms: Ordinary Hazard, Group 1.

General Storage Areas: Ordinary Hazard, Group 1.

Janitors Closets: Ordinary Hazard, Group 1.

Mechanical Equipment Rooms: Ordinary Hazard, Group 1.

Office and Public Areas: Light Hazard.

Minimum Density for Automatic-Sprinkler Piping Design:

Light-Hazard Occupancy: 0.10 gpm/ft^2 over 1500-sq. ft. area

Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm/ft^2 over 1500-sq. ft. area.

Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm/ft^2 over 1500-sq. ft. area.

Extra-Hazard, Group 1 Occupancy: 0.30 gpm/ft^2 over 2500-sq. ft. area.

Extra-Hazard, Group 2 Occupancy: 0.40 gpm/ft^2 over 2500-sq. ft. area.

Special Occupancy Hazard: As determined by Authority Having Jurisdiction.

Area of operation reduction shall be permitted in accordance with NFPA 13, where approved by Authority Having Jurisdiction.

Maximum Suppression Area per Sprinkler:

Light-Hazard Occupancy: 225 sq. ft.

Ordinary-Hazard Occupancy: 130 sq. ft.

Mechanical Equipment Rooms: 130 sq. ft.

Electrical Equipment Rooms: 130 sq. ft.

Other Areas: According to NFPA 13 recommendations, unless otherwise indicated.

Total Combined Hose-Stream Demand Requirement: In accordance with NFPA 13, unless otherwise indicated, as follows:

Light-Hazard Occupancies: 100 gpm for 30 minutes.

Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.

PART 2 - PRODUCTS

PIPE AND FITTINGS

Provide pipe and tube of type, joint type, grade, size and weight (wall thickness or Class) indicated for each service. Where type, grade or class is not indicated, provide proper selection as determined by Installer for installation requirements, and comply with governing regulations and industry standards.

Provide factory-fabricated fittings of type, materials, grade, class and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve or equipment connection in each case. Where not otherwise indicated, comply with governing regulations and industry standards for selections, and with pipe manufacturer's recommendations where applicable.

Pipe and fittings shall be listed for use as fire sprinkler piping.

STEEL PIPE AND FITTINGS

All steel standpipe and sprinkler pipe shall include FM-approved MIC inhibiting coating.

Steel pipe shall comply with ASTM A53, Type E, Grade B for 4" and larger and ASTM A53, Type F, Grade A for 3" and smaller, black for wet pipe systems.

Provide Schedule 40 steel pipe, sizes 2" NPS and smaller. Provide no less than Schedule 10 steel pipe, sizes 2-1/2" NPS and larger. Schedule 10 steel pipe is permitted to be used **only** with listed rolled or swaged groove joints. **Schedule 5 pipe in any size is prohibited.**

All fittings must be listed or approved for the specific pipe and type of system they are used on. For gasketed fittings, install only with the lubricant with which manufacturer obtained listing.

The following joining methods are acceptable to the extent permitted by listings, except threading is accepted for use only on Schedule 40 and heavier pipe and **cut grooves are prohibited**:

Threading

Shop Welding

Roll or Swage Groove with Gasket Fitting

Plain end, hooker, press-on, key type, or slip fittings are prohibited.

Grooved mechanical pipe couplings and fittings for use with rolled or swaged groove carbon steel pipe as hereinbefore specified shall be rated for water service up to 175 psig. All grooved products, fittings and couplings, must be of the same manufacturer and shall be listed for fire suppression service and shall be UL/FM approved. **Joints shall be rigid type.**

Couplings: Malleable iron, ASTM A47 or ductile iron, ASTM A536, fabricated in two or more parts, securely held together by two or more track-head, square, or oval-neck bolts, ASTM A449 and A183.

Gaskets: Rubber product recommended by the coupling manufacturer for the intended service.

Fittings: Malleable iron, ASTM A47; ductile iron, ASTM A536; or steel, ASTM A53 or A106, designed to accept grooved mechanical couplings.

COPPER TUBE AND FITTINGS

Copper Tube: Type K,L,M, ASTM B 88, Type (wall thickness) as specified for each service, hard-drawn temper, except as otherwise indicated.

Copper Braze/Solder-Joint Fittings: Cast copper per ANSI B16.18 or wrought copper per ANSI B16.22, with “type” to match adjacent piping.

Solder joints, shall be fabricated in accordance with the methods and procedures listed in ASTM B 828.

Unless the following are met, joints for the connection of copper tube shall be brazed:

Solder joints shall be permitted for exposed wet pipe systems in light hazard occupancies where the temperature classification of the installed sprinklers is of the ordinary or intermediate temperature classification.

Solder joints shall be permitted for wet pipe systems in light hazard and ordinary (Group 1) occupancies where the piping is concealed, irrespective of sprinkler temperature.

Solder fluxes shall be in accordance with ASTM B 813

Solder Metal shall be in accordance with ASTM B 32

Brazing filler metal shall be in accordance with AWS A5.8

Brazing fluxes shall not be of a highly corrosive type.

FIRE PROTECTION VALVES

Line Control Valves, 2" and Smaller: Provide with screw ends.

Gate Valves: Shall have approval rating 175 psi WWP or greater with body and bonnet made from cast bronze alloy ASTM B-62. Valve to be of OS&Y design. Valve to be Underwriters Laboratories listed, Factory Mutual Approved and in compliance with ANSI/MSS-SP80.

Ball Valves: Shall have approval rating 175 psi WWP or greater with TFE seats. Valve to have gear operator with raised position indicator and two internal supervisory switches. Valves shall be Underwriters Laboratories listed, Factory Mutual Approved and in compliance with ANSI/MSS-SP110.

Trim and Drain Valves, 2" and Smaller: Provide with screw ends.

Ball Valves: Shall have approval rating of 175 psi WWP or greater. Valve to have TFE seats, blowout-proof stem and lever handle. Valve to be Underwriters laboratories listed and Factory Mutual Approved for trim and drain service and in compliance with ANSI/MSS-SP110.

Globe/Angle Valves: Shall have approval rating of 175 psi WWP or greater. Valves to have rubber seat disc and to be UL/FM listed and approved for trim and drain service.
Check Valves: To be rated 175 psi or greater. Valves to have rubber seat discs, be of Y-pattern horizontal swing-type, and shall be in compliance with ANSI/MSS-SP80.

Line Control Valves, 2 1/2" and Larger: Provide with flanged or rolled or swaged groove ends.

Gate Valves: Shall have approval rating of 175 psi WWP or greater, iron body with bronze trim or with resilient rubber encapsulated wedge. Body and bonnet to be of cast iron alloy ASTM A-126 Class B with OS&Y type bonnet. If of resilient wedge design, interior of valve to be epoxy-coated. Valve stem to be pregrooved for use with supervisory switch, if required. Ends to be flanged Class 125 or grooved. Valves to be Underwriters Laboratories listed, Factory Mutual Approved and in compliance with ANSI/MSS-SP70.

Check Valves: Shall have approval rating of 175 psi WWP or greater with bronze trim and rubber to metal seating. Body to be of cast iron alloy ASTM A-126 Class B. Ends to be flanged or wafer for use with Class 125/150 flanges. Valves to be Underwriters laboratories listed, Factory Mutual Approved and in compliance with ANSI/MSS-SP71.

Butterfly Valves: Shall have approval rating of 175 psi WWP or greater. Valves shall have gear operator with hand wheel and raised position indicator and two internal supervisory switches. Bodies to be from cast ductile iron ASTM A395 or A536 and stems to be 400 series stainless steel. Valves shall be wafer style for installation between Class 125/150 flanges or I.P.S. grooved. Valves to be Underwriters Laboratories listed, Factory Mutual Approved and in compliance with ANSI/MSS-SP67. Valves shall be designated to be supervised open or, where required, supervised closed.

SPECIALTY VALVES

All indoor control valves 2" NPS through 8" NPS shall be the butterfly type, with integral tamper switch and position indicator.

AUTOMATIC SPRINKLERS

Sprinkler Heads: Glass bulb or fusible link type, style as indicated or required by the application. Unless otherwise indicated, provide heads with nominal 1/2 inch discharge orifice, for "Ordinary" temperature range. Heads shall be rated and listed for “quick response”.

Heads installed in high humidity locations (bathrooms, natatoriums, etc.) shall have corrosion resistant coating.

Heads shall be wax-coated where installed exposed to acids, chemicals, or other corrosive fumes.

Provide escutcheon plate for each ceiling or wall head.

Sprinkler Head Finishes: Provide heads with the following finishes:

Upright, Pendent, and Sidewall Styles: Chrome plated in finish spaces, exposed to view; rough bronze finish for heads in unfinished spaces and not exposed to view.

Concealed Style: Rough brass, with painted white cover plate.

Flush Style: Bright chrome, with painted white escutcheon plate.

Recessed Style: Bright chrome, with bright chrome escutcheon plate.

Sprinkler Head Cabinet and Wrench: Finished steel cabinet, suitable for wall mounting, with hinged cover and space for 6 spare sprinkler heads plus sprinkler head wrench. Provide a separate cabinet for each style sprinkler head on the project.

PART 3 - EXECUTION

SPRINKLER APPLICATIONS

Sprinkler heads installed in suspended ceilings shall be recessed or concealed pendant type.
Sprinklers installed in areas without ceilings shall be upright type.

Provide sprinkler head guard for heads installed in janitor closets, equipment rooms, gymnasiums, and other spaces where there is potential for damage. Provide sprinkler head guard for all heads located 7 feet or less to the floor.

PIPING APPLICATIONS

Piping after the backflow preventer shall be Steel.

Piping before the backflow preventer shall be flanged cement lined ductile iron.

PIPING INSTALLATION

Fire suppression system piping shall begin at the termination of underground water supply piping provided under Section 212215, 12" above finished floor.

Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. So far as practical, install piping as indicated.

Deviations from approved "Working Plans" for sprinkler piping, require written approval of the authority having jurisdiction. Written approval shall be on file with the A/E prior to deviating from the approved "Working Plans".

Install sprinkler piping to provide for system drainage in accordance with NFPA 13. Provide drain piping to discharge at safe points not greater than 2'-0" above finished grade outside building.

Provide auxiliary drains as required by NFPA 13. In addition, provide a permanently piped drain/test connection at each flow switch.

Use approved fittings to make all changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

Install unions in pipes 2 inch and smaller, adjacent to each valve. Unions are not required on flanged devices or in piping installations using grooved mechanical couplings.
Install flanges on valves, apparatus, and equipment having 2-1/2 inch and larger connections.

In addition to the requirements specified in Section 210529, comply with the requirements of NFPA 13 and NFPA 14. Hanger and support spacing and locations for piping joined with grooved mechanical couplings shall be in accordance with the grooved mechanical coupling manufacturer's written instructions for rigid systems.

Make connections between underground and above-ground piping using an approved transition piece strapped or fastened to prevent separation.

Install mechanical sleeve seal at pipe penetrations in basement and foundation walls in accordance with Section 210517.

Install test connections sized and located in accordance with NFPA 13 complete with shutoff valve. Test connections may also serve as drain pipes. Provide test connections not more than 6 feet above the floor for each sprinkler system or portion of each sprinkler system equipped with an alarm device and locate at the hydraulically most remote part of each system. Provide test connection piping to a location where the discharge will be readily visible and where water may be discharged without damage the building or its site.

Install pressure gage on the riser or feed main at or near each test connection. Provide gage with a connection not less than 1/4 inch and having a soft metal seated globe valve, arranged for draining pipe between gage and valve.

Install gages to permit removal, and where they will not be subject to freezing.

COPPER PIPE INSTALLATION

Construct piping joints as follows:

Install copper tubing according to CDA's *Copper Tube Handbook*.

Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly. For brazed joints for copper tubing, comply with CDA's *Copper Tube Handbook*, "Brazed Joints" chapter.

For soldered joints for copper tubing, apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's *Copper Tube Handbook*.

STEEL PIPE INSTALLATION

Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe, fittings, and valves as follows:

Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.

Align threads at point of assembly.

Apply appropriate tape or thread compound to the external pipe threads.

Assemble joint to appropriate thread depth. When using a wrench on valves place the wrench on the valve end into which the pipe is being threaded.

Do not use pipe with threads which are stripped, chipped, corroded, or otherwise damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

Flanged Joints: Align flanges surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly to appropriate torque specified by the bolt manufacturer.

Mechanical Grooved Joints: Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

End Treatment: After cutting pipe lengths, remove burrs and fins from pipe ends.

VALVES INSTALLATION

General: Install fire suppression specialty valves, fittings, and specialties in accordance with the manufacturer's written instructions, NFPA 13 and 14, and the authority having jurisdiction.

Gate Valves: Install supervised-open gate valves so located to control all courses of water supply except fire department connections. Where there is more than one control valve, provide permanently marked identification signs in accordance with Section 210553, indicating the portion of the system controlled by each valve. Install check valves in each water supply connection.

SPRINKLER HEAD INSTALLATION

Use proper tools to prevent damage during installations.

Wet pipe sprinkler head connections shall be made only from the top of supply piping to eliminate potential sediment clogging.

Use return bends or swing joints to ceiling pendent sprinklers to facilitate centering of sprinklers in ceiling tiles. ***The use of corrugated or braided flexible sprinkler connectors is prohibited.***

FIELD QUALITY CONTROL

Flush, test, and inspect underground water supply piping in accordance with Section 211115.

Flush, test, and inspect sprinkler piping systems in accordance with NFPA 13.
Replace piping system components which do not pass the test procedures specified, and retest repaired portion of the system.

INSTALLATION, TEST, AND CERTIFICATION

All sprinkler valves and controls must be located for safe and convenient access during emergencies and testing. Control valves shall not be located above ceilings.

Identify each valve and control with a prominent engraved phenolic or stamped metal placard.

Any such devices that are behind access doors or panels must also have their location made known by an appropriate placard on the means of access.

The contractor shall thoroughly inspect the completed system to assure compliance with this document, project plans and specs, and applicable Codes and Standards. This shall include an operational test of each waterflow alarm switch and all system supervisory devices (valve tamper, hi-low air pressure, pump status, etc) **in coordination with the fire alarm system subcontractor**.

Pressure tests shall be done with all sprinkler heads installed. System shall be tested in accordance with NFPA 13 or NFPA 14, as applicable. Any leak shall be repaired by remaking of leaking joint and the system shall be retested until no leaks occur.

Where an existing sprinkler system is being expanded or renovated, the contractor shall be responsible for the integrity of all new piping plus existing piping within three feet of new or renovation work.

Prior to the final inspection by the AHJ and/or the owner's representative, complete and submit three (3) copies each of the NFPA-required certificates for aboveground and underground piping.

EXTRA MATERIALS

Furnish to Owner two (2) valve wrenches for each type of sprinkler head installed.

Furnish extra sprinkler heads of each style included in the project, per the following table. Furnish each style with its own sprinkler head cabinet and special wrenches as specified in this Section.

Less than 20 sprinklers	2
21 to 100 sprinklers	4
101 to 299 sprinklers	8
300 to 1000 sprinklers	12
Over 1000	24

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 211000

SECTION 212400 – DRY CHEMICAL FIRE SUPPRESSION SYSTEM

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to this section.

SCOPE

This specification outlines the requirements for a U.L. listed pre-engineered total flooding automatic and manual fire extinguishing system for the paint booths and paint room. The work described in the specification consists of all labor, materials, equipment, and services necessary and required to complete and test the system.

QUALITY ASSURANCE

Standards: The system shall be designed, installed, and tested in accordance with the latest editions or statutes listed below:

NFPA standards 13, 17 and 33 as appropriate.
NCFC chapters 9, 24
Factory Mutual Approval Guide
UL Listings (UL 1254)
State Fire Marshal requirements
Manufacturer's Design and Installation Manuals

Requirements: This installation shall be made in accordance with the drawings, specifications, and applicable standards. Should a conflict occur between the drawings and specifications, the specifications shall prevail.

Exclusion: The work listed below shall be provided under other sections of the specifications.

Interlock conduit and wiring to the building fire alarm system (Division 28)

GENERAL SYSTEM DESCRIPTION(S)

The system and components shall be Monarch Dry Chemical Industrial Fire Suppression System as manufactured by Pyro-Chem, or approved equal by Kidde/Fenwal, ANSUL or Fike.

The equipment shall be supplied and installed by a local factory authorized and trained fire systems distributor.

Qualifications of installer/contractor:

The system shall be installed by an experienced firm regularly engaged in the installation of automatic fire extinguishing systems in strict accordance with NFPA standards. The systems hall be installed and serviced by personnel trained by the manufacturer.

The contractor's firm must have a minimum ten (10) years' experience in design, installation, and testing dry chemical or similar fire suppression systems. A list of systems of similar nature and scope shall be provided at the request of the Engineer.

The installing Contractor shall provide certification of his capability to recharge the largest dry chemical system within 72 hours after discharge.

The installation Contractor shall be an authorized stocking distributor of the manufacturer for the equipment included in the system so that immediate replacement parts can be made from inventory. He shall show proof of available telephone communications on a twenty-four-hour, seven-days-a-week basis; his service personnel shall be available for emergency service at all times.

The dry chemical systems contractor shall show evidence that he carries a minimum $2,000,000.00 liability coverage.

These limits shall supersede limits required in the general conditions of the specifications.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not comply fully with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913, as applicable, for exact requirements.

The following shall be submitted for approval prior to the start of installation:

Shop drawings and components details.

Manufacturer's certificate of acceptance of the qualifications of the installing contractor to install, test, maintain, and recharge the manufacturer's equipment.

Shop drawing shall indicate locations, installation details, and operation details of all equipment associated with the dry chemical system. Floor plans showing equipment locations piping, conduit runs, and other details, as required, be provided. Floor plans shall be drawn to a scale of not less than 1/8" = 1'0". Elevations, cross section, and other details shall be drawn to a larger scale as required.

Sequences of operation, electrical schematics, and connection diagrams shall be provided to completely describe the operation of the dry chemical system control as required.

The contractor shall illustrate the agent distribution system and provide calculations to demonstrate the volumetric concentrations.

PART 2 - PRODUCTS

SYSTEM DESCRIPTION AND OPERATION

The system shall be total flooding UL listed pre-engineered dry chemical fire extinguishing system designed to provide protection from Class A, B and C fires.

The amount of dry chemical to be provided shall be the amount determined by the manufacturer to be required for the hazard involved in accordance with NFPA 17 and the UL listing. Release of the dry chemical, whether automatic or manual, shall result in an alarm condition for the building fire alarm system.

The system shall be automatically actuated by fusible link style detector(s) designed to separate at a specific temperature and manually actuated by a remote pull station. The pull station shall mechanically actuate the fire suppression system.

The system shall be connected to the building fire alarm system and exhaust fans shall be interlocked to shut down upon system activation.

MATERIALS AND EQUIPMENT

General Requirements: Materials and equipment shall be standard products of the manufacturer's latest design and suitable to perform the functions intended. When one or more pieces of equipment must perform the same functions, they shall be duplicates produced by one manufacturer. The name of the manufacturer and the serial numbers shall appear on all major components. Locks for all cabinets shall be keyed alike.

All devices and equipment shall be UL listed and/or FM approved.

All devices, equipment and components shall be products of the same manufacturer.

Detectors shall be the standard response fusible link style designed to separate at a specific temperature and shall be provided with fusible link housing kits. Fusible links shall be connected to the control head by 1/16” cable, routed within electric metallic conduit.

Dry Chemical Tank(s) shall be steel, painted and shall be UL listed and shall meet appropriate Department of Transportation and NFPA requirements. Tank(s) shall be provided with a plated forged brass valve, pressure gauge and fusible plug relief device. Tank(s) shall have a nameplate affixed to its exterior and stamped with contents, pressure and weight information. Tank(s) shall be provided with factory wall mounting bracket(s).

Dry Chemical shall be monoammonium phosphate-based agent for Class A, B and C fires and shall be color coded yellow for easy identification.

Nozzles shall be constructed of brass, aluminum or plated steel with 1/2" or 3/4" NPT threads. Nozzle shall be designed to distribute the dry chemical agent in a uniform pattern throughout the hazard area and shall be protected by plastic blow off caps.

Distribution piping shall be schedule 40 black iron, galvanized steel, chrome-plated or stainless steel pipe and fittings conforming to ASTM A120 or A016. Exterior piping to be galvanized steel.

Releasing Device shall consist of a metal enclosure containing a spring loaded puncture pin release mechanism and a nitrogen actuation cartridge. The releasing device shall be capable of being actuated directly from the detection system and manual pull station. Releasing device shall be provided with a minimum of one Form-C microswitch for connection to the fire alarm system to provide alarm upon agent release.

Nitrogen Cartridge shall be a sealed steel pressure vessel containing nitrogen gas. The nitrogen cartridge seal shall be designed to be punctured by the releasing device to supply the required pressure to actuate the dry chemical agent tank(s).

PART 3 - EXECUTION

DRY CHEMICAL STORAGE AND DISTRIBUTION

Each protected area shall have its own separate supply of dry chemical agent.

Each supply shall be located within the hazard area so that a minimum of distribution piping is used.

The dry chemical agent shall be stored in wall mounted cylindrical containers. Containers shall be super-pressurized with dry nitrogen to 360 PSIG at 70 degrees F. Containers shall be of high-strength alloy steel construction that complies with the Department of Transportation regulation for refillable pressure vessels and conforms to NFPA 17.

Discharge nozzles shall distribute the dry chemical throughout the protected area.

The nozzles shall be Pyro-Chem or equal in quality/function and construction and designed to provide proper distribution and weight of the agent.

All distribution piping shall be in accordance with the latest requirements listed in NFPA Standard 17 for pre-engineered dry chemical fire extinguishing systems.

All pipe length must be reamed, blown clear, and swabbed with suitable solvents to remove burrs, mill varnish, and cutting oil before assembly.

SYSTEM INSPECTION AND CHECKOUT

After the installation is complete, the system shall be inspected by factory trained personnel in accordance with the manufacturer's recommended procedures.
All wiring shall be tested for proper connection, continuity, and resistance to ground.

The complete system shall be functionally tested in the presence of the Owners, in accordance with manufacturer's instruction manual and UL listing, and all functions, including system and equipment interlocks, must be operational at least ten (10) days prior to the final acceptance test.

TRAINING REQUIREMENTS

Prior to final acceptance, the contractor shall provide operation and maintenance instruction to each shift of the Owner's personnel. Each instruction session shall include emergency procedures, system operation, trouble procedures, and safety requirements. Each session shall include a complete demonstration of the system. Dates and times of the training period shall be coordinated through the Owner not less than two weeks prior to session.

OPERATION AND MAINTENANCE

Prior to final acceptance, the contractor shall provide complete operation and maintenance instruction manuals per specification 019913 to the owner. All aspects of system operation and maintenance shall be detailed, including, a written description of the system design, drawing illustrating equipment used in the system. Checklists and procedures for emergency situations, troubleshooting techniques, and maintenance operations shall be included.

AS-BUILT DRAWINGS

Upon completion of each system, the contractor shall provide as-built drawings showing actual installation details, all equipment locations (manual stations, detectors, controls) shall be shown, as well as exact conduit and piping routing details and agent storage positions. One copy of reproducible engineering drawings will be provided reflecting all actual installation details.

ACCEPTANCE TESTS

At the time "as-built" drawings and maintenance/operation manuals are submitted, the contractor shall submit a "Test Plan" which shall describe how the system will be tested. This shall include a step-by-step description of testing procedure. The tests shall demonstrate that the operating and installation requirements of this specification have been met. All tests shall be conducted in the presence of the Owner and at a time mutually agreeable to the owner and contractor.

Tests shall demonstrate the entire system functions as intended. Automatic actuation, manual actuation and fire alarm interface shall be demonstrated. Testing of the system shall include the discharge sufficient of dry chemical to demonstrate that the system is properly installed and functional.

Upon acceptance by Owners, the complete system shall be placed in operation within a nominal twenty-four (24) hour period. The contractor shall provide written certification that all containers are filled as required.

DRY CHEMICAL SYSTEM INSPECTIONS

The contractor shall provide one (1) inspection of each system under this contract during the one-year warranty period.

Documents certifying satisfactory system conditions shall be submitted to the Owner's technical representative upon completion of inspection. All inspections shall be done in accordance with NFPA 17.

WARRANTY

All dry chemical system components furnished under this contract shall be guaranteed against defective design, materials, and workmanship for the full warranty time which is standard with the manufacturer, but in no case less than ONE (1) YEAR from the date of system acceptance.

The dry chemical contractor shall warrant refill of system should there be any accidental discharge of the system during the 1-year warranty period contingent on the following:

System shall be under service contract by the installing dry chemical contractor during the entire warranty period.

Tampering of the system or servicing by any others shall void this warranty.

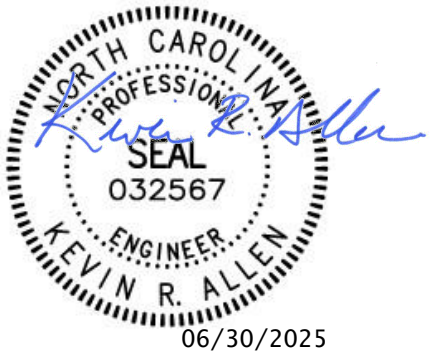
Discharge will not have been caused by operator negligence, sabotage, or release of contaminating media into the detection system.

END OF SECTION 212400

Docusign Envelope ID: A708AC2D-32EE-419A-BBBD-70DD021DD26A

SECTION 220210 – PLUMBING SUMMARY OF WORK

Engineer of Record for plumbing work is Kevin R. Allen, PE, Salas O'Brien Raleigh, Inc., 702 Oberlin Road, Suite 300, Raleigh, NC 27605 (919) 832-8118. Plumbing work shall be defined by drawings numbered with the prefix "P", the general provisions of the Contract including General Conditions and Supplementary Conditions, Division 1 Specifications sections, and Division 22 Technical Specifications listed below. In addition, plumbing work may be defined by reference to other documents from any of the above-named sources as well as by project addenda.



06/30/2025

DIVISION 22 - PLUMBING

Section	Title
220210	Plumbing Summary of Work
220510	Plumbing Basic Requirements
220511	Electrical Provisions for Plumbing Work
220517	Sleeves and Sleeve Seals for Plumbing Piping
220529	Plumbing Hangers and Supports
220553	Plumbing Painting and Identification
220596	Water Heating Systems Commissioning
220700	Plumbing Insulation
221116	Domestic Water Distribution Piping
221125	Natural Gas Piping
221316	Sanitary Waste and Vent Piping
221416	Storm Water Piping
223300	Electric Domestic Water Heaters
224000	Plumbing Fixtures
226500	Laboratory Air, Gas, and Vacuum Systems
226700	Purified Water Systems

END OF SECTION 220210

Docusign Envelope ID: A708AC2D-32EE-419A-BBBD-70DD021DD26A

SECTION 220510 – PLUMBING BASIC REQUIREMENTS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

The requirements specified herein shall govern all Sections in Division 22, whether stated therein or not.

Where items specified in the various sections of this Division conflict with requirements of this Section, the former shall govern.

SUBMITTALS

Specific submittal requirements are defined in each section of this Division.

Welders' and Brazers' Qualifications: Operators who are to do the welding and/or brazing must be properly qualified to do satisfactory work. **Proof of an operator's qualifications shall be either the Contractor's record of suitable tests passed within the preceding six months while in the employ of the Contractor, or tests made before the start of work.** Submit qualification data for each operator prior to their starting work. Any workman considered by the A-E as not having the skill necessary for the work shall be required to pass an appropriate qualification test or shall be at once barred from further welding and/or brazing on the project.

ACOUSTIC PERFORMANCE

It is the intent of this Specification that noise levels due to plumbing equipment will permit attaining sound pressure levels in occupied spaces conforming to the following Room Criteria (RC):

Max. RC	Environment	Typical Occupancy
25	Extremely quiet environment, suppressed speech is audible, suitable for acute pickup of all sounds.	Broadcast or recording studios, concert halls, music rooms, bedrooms, special classrooms for the very young or hearing impaired, foreign language instruction classrooms, etc.
30	Very quiet, suitable for large conferences; telephone use satisfactory; sleeping unimpaired.	Residences, hotel or hospital sleeping rooms, theaters, libraries, executive offices, directors' rooms, large conference rooms, etc.
35	Quiet, suitable for conference at 15 ft. table; normal voice 10-30 feet; telephone use satisfactory.	Private offices, school cafeterias, court rooms, churches, small conference rooms, etc.
40	Satisfactory for conferences at 6-8 ft. table; normal voice 6-12 ft.; telephone use satisfactory	General (open) offices, school corridors, laboratories, restaurant and entertainment facilities, etc.
45	Satisfactory for conferences at 4-5 ft. table; normal voice 3-6 ft., raised voice 6-12 ft; telephone use is somewhat difficult.	Retail stores, cafeterias and fast food dining, lobby or public areas, etc.
50	Unsatisfactory for conferences; normal voice 1-2 ft., raised voice 3-6 ft.; telephone use is difficult.	Workshops, machine rooms, industrial process areas, etc.

For classrooms (including primary education, colleges and universities, training facilities, etc.), all plumbing equipment shall be selected so as to comply with ANSI Standard S12.60.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

PIPING WELDING/BRAZING/SOLDERING

High Pressure Piping (15 Psig or Above): High pressure carbon steel piping systems shall be fabricated, assembled and welded/brazed/soldered in accordance with ASME B31.3, and Power Piping Codes PFI ES 1, PFI ES 3, PFI ES 7, PFI ES 21, PFI ES 31, PFI ES 35, and PFI TB1 of the Piping Fabrication Institute's companion code requirements.

Low Pressure Piping (Below 15 Psig):

Low pressure carbon steel piping systems shall be fabricated, assembled and welded/brazed/soldered in accordance with the ASME B31.9.

Copper piping systems shall be fabricated, assembled and brazed/soldered in accordance with ASTM B828.

END SECTION 220510

SECTION 220511 - ELECTRICAL PROVISIONS FOR PLUMBING WORK

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

The requirements specified herein shall govern all Sections in Division 22, whether stated therein or not.

Where items specified in the other sections of this Division conflict with requirements of this Section, the former shall govern.

DESCRIPTION OF WORK

Work includes, but is not necessarily limited to the following:

Provide electrical heating elements in plumbing equipment.

Provide disconnect switches for all furnished equipment. Disconnect switches shall be sized in accordance with the latest edition of the *National Electrical Code* (NEC) for single motor applications as follows:

Disconnect Switch Sizes for Motors						
Switch Rating Amps (A)	Maximum HP at System Voltage (V))/ Phase (PH)					
	120V/1PH	208V/1PH	240V/1PH	208V/3PH	240V/3PH	480V/3PH
30A	1-1/2	3	3	5	7-1/2	15
60A	3	7-1/2	10	15	15	30
100A	5	10	10	25	25	60
200A	-	-	-	50	60	100
400A	-	-	-	100	125	250
600A	-	-	-	150	200	400

Disconnect switches shall be sized for all other applications based on total kW rating of the equipment as follows:

Disconnect Switch Sizes for Equipment							
Switch Rating Amps (A)	Maximum kW at System Voltage (V)/ Phase (PH)						
	120V/ 1PH	208V/ 1PH	240V/ 1PH	277V/ 1PH	208V/ 3PH	240V/ 3PH	480V/ 3PH
30A	2.8	5.0	5.8	6.6	8.6	10.0	19.9
60A	5.8	10.0	11.5	13.3	17.3	19.9	39.9
100A	9.6	16.6	19.2	22.2	28.8	33.2	66.4
200A	19.2	33.3	38.4	44.3	57.6	66.4	132.9
400A	38.4	66.6	76.8	88.6	115.1	132.9	265.7
600A	57.6	99.8	115.2	133.0	172.7	199.3	398.6

Dual element fuses shall be provided with disconnect switches. Fuses shall be sized based on the nameplate rating for the equipment.

Equipment enclosures for disconnect switches, starters, variable frequency drives, control panels and any other panel enclosures housing electrical equipment shall be rated based on NEMA standard ratings. Panel enclosures shall be suitable for the environment in which they will be installed. Unless noted otherwise, provide NEMA rated enclosures based on the following environment conditions:

NEMA Enclosure Ratings for Electrical Equipment	
NEMA Type	Environment Condition
1	Indoors only, dry, low dust, and non-corrosive environment
3R	Outdoors, weatherproof and rainproof
4	Outdoors, watertight and raintight
4X	Same as 4 plus corrosion resistant
7	Hazardous locations Class I, Groups A, B, C, or D
9	Hazardous locations Class II, Groups E, F, or G
12	Indoors subject to circulating non-hazardous dust, or dripping non-corrosive liquids

Provide all single phase interlock and control wiring required for sequenced operation of plumbing devices provided for plumbing systems under Division 22. Under Divisions 26-28, a source of power for these devices shall be provided and extended to the devices under Division 22.

Make all power wiring connections for plumbing equipment as recommended by the equipment manufacturer. Under Divisions 26-28, power wiring to the line side of a disconnecting means provided and installed under Division 22 will be provided.

Some items of equipment may require conductor and/or raceway combinations different from the supply conductors provided under Division 26-29 to the equipment disconnect; coordinate and provide connections as recommended by the equipment manufacturer.

Division 22 Contractor is responsible for providing and installing fuses in disconnects that supply Division 22 equipment.

Provide any required power wiring not specifically shown on the electrical drawings (E-Sheets) or specified in Divisions 26-28.

QUALITY ASSURANCE

Coordination with Electrical Work: Wherever possible, match elements of electrical provisions of plumbing work with similar elements of electrical work specified in Divisions 26-28 sections. Comply with requirements of applicable Divisions 26-28 sections for raceways and wiring methods associated with final electrical connections to equipment installed under this Division.

Standards:

For electrical equipment and products, comply with applicable NEMA standards and refer to NEMA standards for definitions of terminology herein.

Comply with NFPA 70 (NEC) for workmanship and installation requirements.

Comply with NFPA 70E while performing any electrical work. (Referenced in OSHA 29CFR Part 1910, Subpart S, Appendix A, NFPA 70E is considered by OSHA as the industry practice for electrical safety.)

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data and installation instructions for electrical materials and products.

Source Limitations: Provide motor starters, combination motor starters, and disconnects through one source from a single manufacturer.

PART 2 – PRODUCTS

CIRCUIT AND MOTOR DISCONNECTS

Safety Switches: Provide surface-mounted, heavy duty, steel enclosed safety switches, of types, voltage rating, current rating, and number of poles indicated on this Section.

Switches with no drawing indication of number of poles are three pole types. Switches shall be fusible type, rated as follows unless otherwise specified:

For 480Y/277 V.: Use 600 Volt type, with neutral and grounding bus.

For 208Y/120 V.: Use 250 Volt type, with neutral and grounding bus.

For 120/240 V.: Use 250 Volt type, with neutral and grounding bus.

Where a neutral is not provided to the specific utilization equipment served, the neutral bus can be bonded to the enclosure and used as a grounding bus.

Provide horsepower rated switches incorporating quick-make, quick-break type switches constructed so that switch blades are visible in OFF position with door open. Equip with operating handle which is integral part of enclosure base and whose operating position is easily recognizable. Internal current carrying components shall be high-conductivity copper; switch contacts shall be silver-tungsten type. Fuse holders shall have positive pressure type reinforced fuse clips. Where non-fused disconnect switches are indicated, provide solid copper bus bars in lieu of fuses.

Provide NEMA Type 1 enclosure unless otherwise indicated on the Drawings; provide NEMA Type 3R enclosure where the Drawings indicate weatherproof. Other enclosure types shall be furnished if specifically indicated on the Drawings.

Provide switches that may be locked in either the “ON’ or ‘OFF’ condition with a 1/4" shackle hasp-type lock. Safety switches shall have door interlocks that prevent the door from opening when the operating handle of the switch is in the “on” position. Manual defeat mechanisms shall be provided for the interlocks.

Provide two-pole interlock switches for all disconnects that are used with utilization equipment requiring control connections provided from an alternate power source. The interlock switch is to be configured such that when the disconnect is open the interlock switch is open.

Provide additional interlock switches, auxiliary contacts, plumbing key interlocks, or other accessories as may described by the Drawings.

For all outdoor equipment, provide a fused weatherproof disconnect switch, sized and fused in accordance with manufacturer's requirements.

Fuses shall be furnished by the Contractor. Fuses shall be current limiting type with a minimum AIC rating of 100,000 AMP. The contractor shall furnish Owner with one complete set of spare fuses at the completion of the project.

ELECTRIC HEATING ELEMENTS

Where electric resistance coils and other heating elements are included in plumbing equipment or otherwise indicated as plumbing work, and except as otherwise indicated, provide 120 Volt units where rating is less than 2 kW, higher-voltage single-phase units where rating is 2 kW but less than 5 kW, and higher-voltage 3-phase units where rating is 5 kW and greater.

PART 3 - EXECUTION

GENERAL

Coordinate the exact location of all equipment disconnects with Divisions 26-28 to ensure that disconnects are located within sight of plumbing equipment.

Extend power wiring circuits from load side of termination points provided under Divisions 26-28 to each item of plumbing equipment requiring electrical power. All wiring shall be installed in raceway in compliance with Division 26. Utilize flexible metallic conduit for weatherproof for outdoor locations. Provide all necessary clamps, fitting, connectors, raceways, circuit conductors, etc., for a completely operational system.

INSTALLATION OF CIRCUIT AND MOTOR DISCONNECTS

Install disconnects as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation," and in accordance with recognized industry practices.

Coordinate placement of disconnects with electrical raceway and cable work, as necessary for proper interface. Coordinate exact location of disconnects with equipment electrical connection point.

> Locate disconnects so that they are readily accessible after all project elements are installed. Location selected for disconnects must permit complete opening of the door or cover to the maximum amount permitted by the design of the switch enclosure.

Install disconnects for use with motor-driven appliances and motors within sight of the controllers, as indicated on the Drawings. In addition, each motor shall be provided with an approved disconnecting device within sight of the respective equipment as required by the NEC even though not specifically indicated on the Drawings. Disconnects installed for use with controllers may serve as the disconnecting means for the motor if it is in sight from the motor location and the driven machinery location.

GROUNDING

Provide equipment grounding connections, sufficiently tight to assure a permanent and effective ground.

FIELD QUALITY CONTROL

Subsequent to completion of installation of disconnects and motor starters, energize circuitry and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at project site, then retest to demonstrate compliance; otherwise remove and replace with new units and retest.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 220511

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data, including installation instructions for each type of sleeve and sleeve seal product. Submit expansion compensation schedule showing Manufacturer's figure number, size, location, and features for each required expansion compensation product.

PART 2 - PRODUCTS

SLEEVES

Cast-Iron Pipe: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

Galvanized-Steel Pipe: ASTM A 53, Schedule 40, with plain ends and welded steel collar; zinc coated.

Galvanized Sheet Metal: Factory-fabricated of G90 galvanized sheet metal with lock-type longitudinal seam, minimum 18 ga.

SLEEVE-SEAL SYSTEMS

Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

Pressure Plates: Stainless steel.

Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

GROUT

Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

Characteristics: Nonshrink; recommended for interior and exterior applications.

Design Mix: 5000-psi, 28-day compressive strength.

Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

SLEEVE AND SLEEVE-SEAL APPLICATIONS

Use sleeves and sleeve seals for the following piping-penetration applications:

Penetration **Application**	Sleeve **Type**	Sleeve-Seal Required
Exterior walls above grade	Cast Iron	Yes
Exterior walls below grade	Cast Iron	Yes
Concrete slab on grade	Cast Iron	Yes
Concrete slab above grade	Galvanized Steel Pipe	No
Interior partitions, fire-rated	Galvanized Steel Pipe	No
Interior partitions, non-fire-rated	Galvanized Steel Pipe or Galvanized Sheet Metal	No

SLEEVE INSTALLATION

Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

Sleeves are not required for core-drilled holes. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

Cut sleeves to length for mounting flush with both surfaces.

Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

Install sleeves for pipes passing through interior partitions. Cut sleeves to length for mounting flush with both surfaces and install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.

For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 019913.

SLEEVE-SEAL-SYSTEM INSTALLATION

Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

SLEEVE-SEAL-FITTING INSTALLATION

Install sleeve-seal fittings in new walls and slabs as they are constructed.

Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
Secure nailing flanges to concrete forms.

Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 220517

SECTION 220529 – PLUMBING HANGERS AND SUPPORTS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry, Inc. Standard Compliance: Comply with MSS SP-58 *Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation* for pipe hangers and supports.

ASTM Compliance: Structural steel elements utilized for piping or equipment support shall comply with ASTM A 36.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data, including installation instructions for each type of support and anchor.

PART 2 - PRODUCTS

GENERAL

Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

Design supports for multiple pipes, including floor stands, to be capable of supporting combined weight of supported systems and system contents.

Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

Structural support elements shall be fabricated from standard structural shapes complying with ASTM A 36 and/or from preformed channel struts.

Preformed channel struts shall be 1-5/8 inches wide by height required to meet load capacities and designs indicated on the drawings. Strut shall be made from steel meeting the minimum mechanical properties of ASTM A653 SS, Grade 33, G90 galvanized. Fittings shall be manufactured from steel meeting the minimum requirements of ASTM A907 SS, Grade 33. All fittings and hardware shall be zinc plated in accordance with ASTM B633, SC3 for fittings and SC1 for threaded hardware. Channel members shall be "Unistrut", Allied Support Systems "Power Strut", or Cooper B-Line Systems, Inc. "Strut System", specifically sized in accordance with the criteria hereinbefore specified.

Building attachments for hangers and supports shall be as indicated on the Drawings. Where attachments are not indicated, they shall be as follows:

Attachment To	Attachment Method(s)
Concrete	Bolt to channel-type concrete inserts or utilize expansion anchors. Size concrete housekeeping pads so expansion anchors will be a minimum of 10 bolt diameters from the edge of the concrete base. Drill at locations and to depths that avoid reinforcing bars.
Solid Concrete Masonry Unit Walls	Use expansion anchors.
Hollow Walls	Bolt to slotted steel channels fastened to wall with expansion anchors.
Wood Structural Members	Install bolts through members.
Steel	Bolt hangers to MSS Type 19, 21, or 23 clamps on flanges of beams or on upper truss chords of bar joists. **To avoid stressing building steel structural elements, provide additional steel support members that span at least two beams or bar joists as required or as shown on the Drawings.** Attach additional steel support members via welding in accordance with AWS standards.

PIPE HANGERS AND SUPPORTS

Horizontal Pipe Hangers: Except as otherwise indicated, provide factory-fabricated horizontal-piping hangers complying with MSS SP-58, of the following MSS types listed, to suit horizontal-piping systems:

For exterior and wet/damp locations, hangers and rods are to be hot dipped galvanized.

Adjustable Steel Clevis Hangers: MSS Type 1.

Copper Pipe Hangers: Copper-plated or -coated steel.

Insulation Protection: Provide MSS Type 40 insulation shield at each pipe support.

Trapeze Pipe Hangers: Trapeze hangers shall be field-fabricated from structural steel members or from preformed channel members and suspended by all-thread hanger rods; weld steel, as required, in accordance with AWS standards. Each pipe on a trapeze hanger shall be individually supported as follows:

Adjustable Pipe Saddle: MSS Type 36 with adjustable support Classification Types 2 and 3 piping.

Adjustable Pipe Roller: MSS Type 41 with adjustable supports for Classification Type 1 piping.

Copper Pipe Saddle: Copper-plated or -coated steel.

Insulation Protection: Provide MSS Type 40 insulation shield at each pipe support.

Rooftop Pipe Supports: Provide roof pipe rails of G235 galvanized steel construction, 14 gauge, in compliance with ASTM A-446, 525, 526 and 527, with welded corners and 3" raised cant fully mitered with seams joined by continuous welds. Supports shall be internally reinforced with bulkheads and spreaders 24" on center, have factory installed 2 x 4 or 2 x 6 wood nailer and 18 ga. counterflashing. Height to be 17" above roof deck or as detailed on the Drawings. Support shall be level at the top with pitch built-in when deck slopes 1/4 of an inch per foot or greater.

Each pipe on a rooftop pipe rail shall be individually supported as follows:

Adjustable Pipe Saddle: MSS Type 36 with adjustable support.

Copper Pipe Saddle: Copper-plated or -coated steel.

Insulation Protection: Provide MSS Type 40 insulation shield at each pipe support.

Exception: Uninsulated piping and raceway, 2" NPS and smaller, may be supported using manufactured, weather-resistant bearing blocks with preformed channel strut load-bearing surface and matching pipe clamps, placed directly on the roof membrane. Supports shall be Cooper B-Line Systems, Inc. "Dura-Blok" or equivalent.

Vertical Piping: Provide factory-fabricated riser clamps complying with MSS Type 8 to support vertical piping systems. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide copper-plated clamps for copper-piping systems.

Pipe Stands: Where indicated on the drawing, support piping with shop- or field-fabricated assemblies made of Sch. 40 black steel pipe and corrosion-resistant components. Stands shall consist of floor plate with anchors, vertical column, and pipe or equipment support element for the required application.

Outdoors: Hangers and struts located outdoors shall be hot dip galvanized after fabrication in accordance with ASTM A123. All hanger hardware shall be hot dip galvanized or stainless steel. Zinc plated hardware is not acceptable for outdoor or corrosive use.

Corrosive Area Finishes: Hangers and struts located in corrosive areas shall be type 304 stainless steel with stainless steel hardware.

EQUIPMENT HANGERS AND SUPPORTS

Floor-Mounted Equipment: Floor-mounted equipment shall be installed on housekeeping pad in accordance with Section 019913 and as specified above.

Suspended Equipment: For suspended equipment, the Contractor shall provide structural steel framing to distribute the imposed operating loads without stressing building structural elements or causing damage to the building substrate. Weld steel in accordance with AWS standards.

Rooftop-Mounted Equipment: Equipment shall be mounted on structural steel supports or on roof equipment curbs or rails, as indicated on the Drawings:

Structural steel supports shall be as detailed on the Drawings.

Equipment roof rails shall be as specified above for rooftop pipe supports. Provide structural steel reinforcement below roof to avoid stressing building structural elements as required.

PART 3 - EXECUTION

INSTALLATION OF HANGERS AND SUPPORTS

Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping and to exactly fit around piping insulation for insulated piping.

Arrange for grouping of parallel runs of horizontal suspended piping to be supported together on trapeze type hangers where possible. Install supports with maximum span and all-thread hanger rods in accordance with the following:

Nominal Pipe Size (in.)	Max. Span for Copper Tubing (ft.)	Max. Span for Steel Pipe (ft.)	Min. All-Thread Hanger Rod Size (in.)
<1	5	7	3/8
1 to 1-1/4	6	7	3/8
1-1/2	8	9	3/8
2	8	10	3/8
2 -1/2	9	10	1/2
3	10	12	1/2
4	10	12	5/8
6	10	12	3/4
8-12	10	12	7/8

Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe.

Rigid plastic piping (ABS, PVC, CPVC, etc.) shall be suspended with adjustable band pipe hangers, MSS Type 10, with factory-fabricated, welded-in support shield. Maximum hanger spacing shall be 50% of the maximum span allowed for steel piping.

Where piping of various types and/or sizes is supported together by a trapeze hanger, space hangers based on the lowest maximum span allowed or install intermediate supports for pipe requiring more frequent support.

Hangers and supports for piping shall be attached to the building structure; **attachment to other piping, ductwork, or equipment is prohibited. The use of wire or perforated strap hangers is prohibited.**

Except as allowed for uninsulated piping 2" NPS and smaller, piping installed on roofs shall be supported by pipe supports anchored to roof rails. Install and anchor pipe rails to the roof deck before roofing insulation and membrane are installed.

INSTALLATION OF EQUIPMENT HANGERS AND SUPPORTS

Floor-mounted equipment shall be installed level and plumb on housekeeping pads in accordance with Section 019913.

Suspended equipment shall be supported by structural steel members or preformed channel struts with all-thread rod hangers. As required, vibration isolations required by Section 220548 shall be installed between the supports and the hangers. Suspended units shall be installed level and plumb.

Hangers and supports for equipment shall be attached to the building structure; **attachment to ductwork or piping is prohibited. The use of wire or perforated strap hangers is prohibited.**

END OF SECTION 220529

SECTION 220553 - PLUMBING PAINTING AND IDENTIFICATION

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data and installation instructions.

PART 2 - PRODUCTS

PAINT FOR PLUMBING

Ferrous Surfaces:

1 coat of fast drying, low VOC acrylic modified medium oil alkyd universal primer
2 coats of fast drying, low VOC alkyd gloss enamel

Fabric Covering Insulation:

1 coat glue sizing
1 coat primer/sealer
1 coat fast drying, low VOC alkyd gloss enamel

PLASTIC LABELS FOR EQUIPMENT

General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, minimum 2-1/2" X 3/4", 1/16" thick, engraved with engraver's standard letter style of black with white letter color, minimum 1/4" high, and punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

Fasteners: Self-tapping stainless steel screws.

Content for Equipment: Equipment's designation as show on Drawings or Owner's unique equipment number. Contractor shall determine requirements prior to fabricating labels.

PIPE LABELS

Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1, except as hereinafter specified. Provide full-band pipe markers, extending 360 degrees around pipe at each location that attach without fasteners or adhesives.

Content: Provide minimum 1-1/4" high lettering to identify piping service using the same designations and abbreviations used on the Drawings. Include arrow indicating flow direction(s). Steam lines shall indicate pressure.

VALVE TAGS

Brass Valve Tags: Provide 0.032" thick polished brass valve tags, minimum 1-1/2" diameter, with stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener.

Valve Tag Fasteners: Provide solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves,and manufactured specifically for that purpose.

PART 3 - EXECUTION

PAINTING

Equipment specified in other sections of Division 22 to be provided with factory-applied finish painting shall not be field-painted. All finish painted equipment shall be touched up where factory paint is chipped, scratched, or otherwise damaged.

All equipment not factory finish painted shall be furnished in prime coat. All prime coated equipment shall be touched up where prime coats are chipped, scratched, or otherwise damaged. All prime coated equipment shall be thoroughly cleaned and left ready for finish painting.

All welds on both insulated and non-insulated piping shall be painted with one coat of primer. Miscellaneous black steel items such as hangers and rods, machinery supports, breechings and stacks, etc., that are not shop primed, shall be field painted with one coat of primer. All metal surfaces shall be thoroughly cleaned of rust and dirt and shall be degreased before application of primer.

Where cast iron accessories or galvanized pipe, duct, or equipment surfaces are to receive finish painting, the item shall be properly cleaned of mill residue before priming. Use primer specific to the application.

Finish painting of equipment, piping, ducts, plenums, casings, breechings, stacks, insulation, etc., located in mechanical equipment rooms and spaces where equipment, piping, etc. is exposed to view shall be provided. Where indicated or specified, existing equipment, piping, duct, etc., shall be cleaned and painted along with new work.

Equipment, vents, etc. where installed on metal roofs shall be finished/painted to match roof color.

Exposed To View Non-Mechanical Spaces: Architect/Owner to select colors for finish painting.

Exposed To View Mechanical Spaces: If the Owner has an existing color schedule, the Contractor shall utilize schedule colors for all finish painting. Otherwise, finish colors shall be as follows:

Note: Where positive pressure gas piping systems operate at pressures other than standard gauge pressure per NFPA 99, pipe label shall include operating pressure.

Item	Label/Paint Color	Text Color	Identification
Piping: Domestic Cold Water	Green	White	DCW
Domestic Hot Water	Green	White	DHW
Domestic Hot Water Return	Green	White	DHWR
Deionized Water	Green	White	DIW
Compressed Air	Blue	White	CA
Natural Gas	Yellow	White	NAT GAS
Vacuum	White	Black	VAC
Acid Waste	Orange	Black	ACID WASTE
Equipment	Haze Grey	White	Refer to drawings
All Other	ANSI A13, NFPA 99		

PLUMBING IDENTIFICATION

Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

EQUIPMENT IDENTIFICATION

Install plastic equipment label on or near each major item of plumbing equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide labels for each of the following general categories of equipment and operational devices:

Main control and operating valves, including safety devices and hazardous units such as gas outlets.

Meters, gages, thermometers and similar units.

Fuel-burning units, including hot water heaters.

Pumps, compressors, and similar motor-driven units.

PIPING IDENTIFICATION

Provide pipe labels as follows wherever piping is exposed to view in finished spaces, in equipment rooms, in accessible maintenance spaces (shafts, tunnels, plenums), or concealed above lay-in ceilings. Label piping installed outdoors that is exposed to view.

Near each valve and control device.

Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch where there could be question of flow pattern.

Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.

At access doors, manholes and similar access points which permit view of concealed piping.

Near major equipment items and other points of origination and termination.
Spaced at maximum spacing of 25' along each piping run.

VALVE IDENTIFICATION

Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibs, and shut-off valves at plumbing fixtures, and similar rough-in connections of end-use fixtures and units.

List each tagged valve in valve schedule for each piping system. Mount valve tag schedule in a frame with a glass cover in the primary mechanical room and include schedule(s) as part of the operating and maintenance data defined in Section 019913.

CEILING IDENTIFICATION

For equipment located above an acoustical lay-in ceiling, provide a clear adhesive label on the ceiling grid directly below the equipment. The label shall indicate in black text the equipment designation.

Provide green colored adhesive 3/4" diameter vinyl “buttons” on the ceiling grid where valves, access doors, etc. are located above.

END OF SECTION 220553

SECTION 220596 – WATER HEATING SYSTEMS COMMISSIONING

PART 1 – GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

GENERAL

Water Heating Systems commissioning shall be performed by the Contractor and shall include the following:

Establish a commissioning "team" consisting of the installing personnel, equipment representative and the plumbing contractor.

Systematically evaluate all water heating system components, equipment, subsystems, and systems to ensure that they are working in accordance with this design documents. This includes measuring temperatures and flow rates from all water heater system devices and calibrating all sensors to a known standard.

Perform commissioning procedures, equipment functional performance tests, and tests of the sequences of operations to verify that the controls are providing the correct interaction between equipment, subsystems, and systems.

PART 2 – DESIGN INTENT

GENERAL

The contract documents define the requirements for water heating system components, equipment, subsystems, and systems, along with the control requirements for each element. It is the intent of the Designer that all water heating components, equipment, subsystems, and systems shall perform in accordance with the stipulated requirements through the entire operational range of each element.

PART 3 – FUNCTIONAL PERFORMANCE

SYSTEMS START-UP

Appendix 220596 outlines basic start up and check out requirements. Generally, these procedures are the direct responsibility of the Contractor as a basic element of validating that the installation is correct. These items provide a minimum or guideline for development of start up procedures, checklists and tests along with the general requirements indicated above (that are common to all). **Contractor shall synthesize these requirements with that of the manufacturer's and/or applicable codes and standards to develop specific and itemized start up procedures specific to that installed on this project.**

FUNCTIONAL PERFORMANCE TESTS AND CERTIFICATION

Functional performance tests shall be performed in accordance with the checklists in Appendix 220596 to prove all modes of the sequences of operation and to verify all other relevant contract requirements. Tests shall begin with equipment or components and shall progress through subsystems to complete systems. Upon failure of any functional performance test checklist item, the Contractor shall correct all deficiencies in accordance with the applicable contract requirements. **The checklist shall then be repeated until it has been completed with no errors.**

Functional performance tests shall begin only after all work and testing required in related specification sections have been successfully completed, after all pre-commissioning checks have been successfully completed, after the control systems are fully functional, after the testing, adjusting, and balancing work has been completed and after all test and inspection reports and operation and maintenance manuals required have been submitted and reviewed by the A/E.

Based on the functional performance test checklists in Appendix 220596, the commissioning team shall prepare standardized reporting forms for each item of equipment, subsystem, and system to document the required functional performance tests. Each test shall be certified with the following statement and the signature and date of signing by each member of the team:

"We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

"Signature and Date:

Contractor's Representative _____
Manufacturer's Representative _____
Controls Sub-Contactor Representative _____"

END OF SECTION 220596

APPENDIX 220596 – WATER HEATING SYSTEMS COMMISSIONING CHECKLISTS

Section	Component
223300	Electric Water Heaters

START-UP CHECKS

Confirm that heater has been flushed and cleaned in accordance with manufacturer's written instructions.

Coordinate heater checks and tests with requirements of Section 223300.

START-UP PROCEDURES

Manufacturer's service representative, utilizing written manufacturer's start-up procedures shall start the Water Heater(s).

Adjust burner(s) for maximum firing efficiency.

FUNCTIONAL PERFORMANCE TESTS

Start building domestic hot water appliances and/or open hot water faucets to provide load for heater(s).

Record the supply temperature leaving mixing valve and compare to design.

Balance system circuit setters and other flow balancing devices.

Confirm hot water recirculation pump operation.

Verify temperatures recorded above are in accordance with the specified reset schedule.

Verify proper operation of safeties. Describe and document any unusual vibration, noise, etc.

END APPENDIX 220596

SECTION 220700 - PLUMBING INSULATION

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 225) method.

> Exception: Outdoor mechanical insulation may have flame spread index of 75 and smoke developed index of 150.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.

Samples: Submit, if requested by A-E, manufacturer's sample of each piping insulation type required, and of each duct and equipment insulation type required. Affix label to sample completely describing product.

PART 2 - PRODUCTS

PIPING INSULATION MATERIALS

Mineral Fiber Insulation:

> Insulation shall be made of fibers manufactured from glass, rock, or slag, processed from the molten state, with or without a binder.
>
> Insulation shall be heavy density pre-formed sectional type for pipe and in accordance with ASTM C 547, Class I, factory-jacketed.
>
> Glass fiber insulation shall be rated for fluid temperature up to 850-degrees F.
>
> Mineral wool insulation shall be rated for fluid temperature to 1200-degrees F.

Insulation Protection: Provide MSS Type 40 insulation shield for Classification Types 1A, 2, and 3 piping at each pipe support.

Jackets for Piping Insulation: Insulation jackets shall be all-service vapor retarder type as follows:

Piping Operating at Temperatures Above Ambient: Jacket shall be "ASJ" type, consisting of white, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
Piping Operating at Temperatures Below Ambient: Jacket shall be one of the following:

FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.

Exception: Piping insulated with cellular glass may have ASJ jacket.

Covering for Piping Insulation Exposed to View:

Encase all indoor straight piping insulation with glossy, 20-mil high impact UV- resistant PVC jacket meeting requirements of ASTM D 1784, Class 16353-C. **Jackets shall have integral colors as required by Section 220553.**

Encase all indoor pipe fittings insulation with one-piece pre-molded 20-mil UV-inhibited PVC fitting covers complying with ASTM C450 for dimensions and fastened as per manufacturer's recommendations. **Jackets shall have integral colors as required by Section 220553.**

EQUIPMENT INSULATION MATERIALS

Mineral Fiber Insulation: Insulation made up of fibers manufactured of glass, rock, or slag, processed from the molten state, with or without a binder.

Mineral Fiber Board Insulation: Comply with ASTM C 612, Type IA or IB, without factory-applied jacket.

High Temperature Mineral Fiber Board Insulation: Comply with ASTM C 612, Type III, without factory-applied jacket.

Equipment Operating at Temperatures Below Ambient: Jacket shall be one of the following:

FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.

Jacketing Material for Equipment Insulation: Insulated equipment exposed to view shall have field-applied jacket as follows:

Encase all equipment insulation with glossy, 20-mil high impact UV- resistant PVC jacket meeting requirements of ASTM D 1784, Class 16353-C. **Jackets shall have integral colors as required by Section 230553.**

PART 3 - EXECUTION

PIPING SYSTEMS INSULATION APPLICATIONS

Piping systems shall be classified in accordance with MSS SP-58, as follows, and be insulated as hereinafter specified:

Classification	Temperature Range (deg F)
Type 1: Hot Systems	Type 1A: 100-200
Type 2: Ambient Systems	71-99
Type 3: Cold Systems	Type 3A: 32-70

Classification Type 1A Piping: Insulate the following plumbing piping systems:

Potable hot water piping.

Potable hot water recirculating piping.

Insulate with mineral fiber, 1-1/2 " thick for pipe sizes up to and including 1-1/4", 2" thick for pipe sizes 1-1/2" and larger.

Exception: Omit insulation on chrome-plated exposed piping (except for handicapped fixtures), air chambers, unions, strainers, check valves, balance cocks, flow regulators, drain lines from water coolers, drainage piping located in crawl spaces or tunnels, buried piping, fire protection piping, and pre- insulated equipment.

Classification Type 3A Piping: Insulate the following plumbing piping systems:

Potable cold water piping.

Interior, horizontal above ground primary and secondary roof drainage piping.

Plumbing vents within 6 feet of roof outlet.

P-trap and Interior, horizontal waste piping from floor drains receiving cooling coil condensate drainage to connection point with waste main piping.

Insulate with mineral fiber, 1" thick for pipe sizes up to and including 2", 1-1/2" thick for pipe sizes 2-1/2" and larger.

Insulate with mineral wool insulation, 1-1/2" thick for pipe sizes up to and including 1", 2" thick for pipe sizes 1-1/4" through 2", and 2-1/2" thick for pipe sizes over 2".

Exception: Omit insulation on chrome-plated exposed piping (except for handicapped fixtures), air chambers, unions, strainers, check valves, balance cocks, flow regulators, drain lines from water coolers, drainage piping located in crawl spaces or tunnels, buried piping, fire protection piping, and pre- insulated equipment.

EQUIPMENT INSULATION APPLICATIONS

Cold Equipment (Below Ambient Temperature):

Application Requirements: Insulate the following cold equipment:

Roof drain bodies.

Insulate with one of the following types and thicknesses of insulation:

Mineral Fiber: 2" thick for surfaces above 35 deg F and 3" thick for surfaces 35 deg F and lower.

GENERAL PIPING INSULATION INSTALLATION REQUIREMENTS

Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

For Classification Type 3A piping, do not insulate valves, strainers, unions, and other accessories.

Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

Install insulation with longitudinal seams at top and bottom of horizontal runs.

Install multiple layers of insulation with longitudinal and end seams staggered.

Do not weld pins, clips, or other insulation attachment devices to piping, fittings, and specialties.

Keep insulation materials dry during application and finishing.

Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

Install insulation with least number of joints practical.

Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

Install insulation continuously through hangers and around anchor attachments:

At pipe hangers and supports, protect the insulation from compression by installing cellular glass piping insulation for the length of the insulation shield specified above.

Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

Install insulation with factory-applied jackets as follows:

Draw jacket tight and smooth.

Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket.

Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

For below-ambient services, apply vapor-barrier mastic over staples.

Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.

Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

PIPING INSULATION INSTALLATION AT PENETRATIONS

Roof Penetrations: Install insulation continuously through roof penetrations.

Seal penetrations with flashing sealant.

For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.

Seal jacket to roof flashing with flashing sealant.

Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

Seal penetrations with flashing sealant.

For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.

Seal jacket to wall flashing with flashing sealant.

Interior Wall, Partition, and Floor Penetrations: Install insulation continuously through walls, partitions, and floors. Seal penetrations through fire-rated assemblies complying with requirements of Section 019913 for firestopping and fire-resistive joint sealers.

INSTALLATION OF MINERAL FIBER PIPING INSULATION

Insulation Installation on Straight Pipes and Tubes:

Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.

For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

Insulation Installation on Pipe Flanges:

Install preformed pipe insulation to outer diameter of pipe flange.

Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.

Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

Insulation Installation on Pipe Fittings and Elbows:

Install preformed sections of same material as straight segments of pipe insulation when available.

When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

Insulation Installation on Valves and Pipe Specialties:

Install preformed sections of same material as straight segments of pipe insulation when available.

When preformed sections are not available, install mitered sections of pipe insulation to valve body.

Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

Install insulation to flanges as specified for flange insulation application.

GENERAL EQUIPMENT INSULATION INSTALLATION REQUIREMENTS

Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the surface area of equipment.

Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment as specified in insulation system schedules.

Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

Install insulation with longitudinal seams at top and bottom of horizontal runs.

Install multiple layers of insulation with longitudinal and end seams staggered.

Keep insulation materials dry during application and finishing.
Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

Install insulation with least number of joints practical.

Where vapor barrier is required, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

Install insulation continuously through hangers and around anchor attachments.
For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

Install insulation with factory-applied jackets as follows:

Draw jacket tight and smooth.

Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket.

Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap.

Staple laps with outward clinching staples along edge at 2 inches o.c.

For below ambient services, apply vapor-barrier mastic over staples.

Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.

Where vapor barriers are required, apply vapor-barrier mastic on seams and joints.

Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

Repair damaged insulation replacing insulation. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

For equipment operating at above ambient temperature, do not insulate the following:

Vibration-control devices.

Testing agency labels and stamps.

Nameplates and data plates.

Manholes.

Handholes.

MINERAL FIBER EQUIPMENT INSULATION INSTALLATION

Apply adhesives according to manufacturer's recommended coverage rates per unit area for coverage of tank and vessel surfaces.

Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.

Protect exposed corners with secured corner angles.
Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

Do not weld anchor pins to ASME-labeled pressure vessels.

Select insulation hangers and adhesive that are compatible with service temperature and with substrate.

On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.

Anchor insulation with speed washers; do not over-compress insulation during installation.

Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.

Impale insulation over anchor pins and attach speed washers.

Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.

Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.

Stagger joints between insulation layers at least 3 inches.

Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.

Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.

For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

FIELD-APPLIED INSULATION JACKET INSTALLATION

Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

EXISTING INSULATION REPAIR

Repair damaged sections of existing mechanical insulation damaged during this construction period. Use insulation of same thickness as existing insulation, install new jacket lapping and sealed over existing.

END OF SECTION 220700

SECTION 221116 –DOMESTIC WATER DISTRIBUTION PIPING

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

SCOPE

Domestic water distribution piping and components inside the building, extending to 10' beyond the walls of the building, shall be provided under this section.

QUALITY ASSURANCE

MSS Compliance: Valves shall comply with Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS) standards as referenced hereinafter. Mark valves in accordance with MSS SP-25.

ANSI Compliance: For face-to-face and end-to-end dimensions of flanged-end valve bodies, comply with ANSI B16.10 "Face-to-Face and End-to-End Dimensions of Ferrous Valves."

ASME Compliance: Fabricate and stamp pressure-temperature relief valves to comply with ASME Boiler and Pressure Vessel Code.

Welding: Qualify welding procedures, welders and operators in accordance with ASME B31.1, or ASME B31.9, as applicable, for shop and project site welding of piping work.

Soldering/Brazing: Procedures shall conform to ANSI B9.1.

NSF Labels: Non-metallic water piping shall comply with NSF 61 and NSF P171 Cl-R standards.

Piping Identification: Each length of pipe and pipe fitting, trap, etc. installed as part of a plumbing system shall bear the identification of the manufacturer and the applicable standard to which it was manufactured.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this Specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data and installation instructions for water piping materials and products.

PART 2 - PRODUCTS

BASIC PIPE AND PIPE FITTINGS

Piping Materials: Provide pipe and tube of type, joint type, grade, size and weight (wall thickness or Class) indicated for each service. Where type, grade or class is not indicated, provide proper selection as determined by Installer for installation requirements, and comply with governing regulations and industry standards.

Pipe/Tube Fittings: Provide factory-fabricated fittings of type, materials, grade, class and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve or equipment connection in each case. Where not otherwise indicated, comply with governing regulations and industry standards for selections, and with pipe manufacturer's recommendations where applicable.

COPPER TUBE AND FITTINGS

Copper Tube: ASTM B 88, Type (wall thickness) as specified for each service, hard-drawn temper, except as otherwise indicated.

Copper Braze/Solder-Joint Fittings: Cast copper per ANSI B16.18 or wrought copper per ANSI B16.22, with “type” to match adjacent piping.

Brass Pipe Flanges: ANSI B16.1, cast brass, with heavy head machine bolts or cap screws, ASTM A193-B7 steel alloy, with hex full nuts, Type 304 stainless steel per ASTM A194-Gr. 2H. Gasket shall be 1/8” natural rubber, 35-45 Durometer hardness.

Copper-Tube Unions: Provide unions with cast copper alloy body with ball-and-socket, metal-to-metal seating surfaces complying with MSS SP--123.

MISCELLANEOUS PIPING MATERIALS

Welding Materials: Except as otherwise indicated, provide welding materials to comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials.

Soldering Materials: Except as otherwise indicated, provide soldering materials as follows:

Tin-Antimony Solder: ASTM B 32, Grade 95TA

Silver-Lead Solder: ASTM B 32, Grade 96TS (Shall not be used on potable water systems.)

Brazing Filler Metals: AWS A5.8, BCuP Series.

Gaskets for Flanged Joints: ANSI B16.21, full-faced for cast-iron flanges, raised-face for steel flanges, unless otherwise indicated.

Piping Connectors for Dissimilar Non-Pressure Pipe: Elastomeric annular ring insert, or elastomeric flexible coupling secured at each end with stainless steel clamps, sized for exact fit to pipe ends and subject to approval by plumbing code.

VALVES

Sizes: Unless otherwise indicated, provide valves of same size as upstream pipe size.

Operators: Provide handwheels, fastened to valve stem, for valves other than quarter-turn. Provide lever handle for quarter-turn valves 6" and smaller, other than plug valves. Provide valve stem extensions for valves installed in insulated piping.

Valves 2" and smaller: Provide with screw or solder ends to match piping.

Ball Valves: Valves shall be rated 150 psi SWP and 600 psi non-shock WOG and will have 2 piece cast bronze bodies, TFE seats, full port, separate packnut with adjustable stem packing, stainless steel anti-blowout stems and stainless steel ball, and be manufactured to comply with MSS SP-110.

Gate Valves: Valves shall be Class 125 rising stem, union bonnet, solid wedge and manufactured in accordance with MSS SP- 80. Body, bonnet and wedge are to be bronze ASTM B-62. Stems shall be of dezincification-resistant silicon bronze ASTM B-371 or low-zinc alloy B-99, non-asbestos packing and malleable or ductile iron handwheel.

Globe/Angle Valves: Valves shall be Class 125 and manufactured in accordance with MSS SP-80; body and bonnet are to be of bronze ASTM B-62. Stems shall be of dezincification-resistant silicon bronze ASTM B-371 or low-zinc alloy B-99, non-asbestos packing, TFE seat disc and malleable or ductile iron handwheel.

Check Valves: Valves shall be Y-pattern swing-type manufactured in accordance with MSS SP-80, Class 125, bronze ASTM B-62 body with TFE seat disc.

Balance Cocks: Class 125, bronze body, bronze plug, screw driver operated, straight or angle pattern.

Valves 2 1/2" and Larger: Provide with flanged ends complying with Class 150 ANSI B16.5. Working Pressure and temperature shall comply with ANSI B 16.34.

Ball Valve: Valves to be rated at 150 psi SWP, 600 psi non-shock WOG, and will have 3 piece cast bronze body, RPTFE seats and packing stainless steel anti-blowout stems, stainless steel ball.

Gate Valves: Valves shall be Class 125 rising stem, union bonnet, solid wedge and manufactured in accordance with MSS SP-80. Body, bonnet and wedge are to be of bronze ASTM B-62. Stems shall be of dezincification-resistant silicon bronze ASTM B-371 or low-zinc alloy B-99, non-asbestos packing and malleable or ductile iron handwheel.

Butterfly Valves: Valves shall be full lug style manufactured in accordance with MSS SP-67 rated at least 200 psi non-shock cold water working pressure. Body to be cast iron or ductile iron. Valves to have aluminum bronze alloy disc with EPDM rubber seat and seals or EPDM rubber encapsulated disc with polymer-coated body. Stem shall be 400 series stainless and shall not have exposed stem to disc fasteners.

Gate, Globe/Angle Valves: Valves to be Class 125 manufactured in accordance with MSS SP-70 (gate) or MSS SP-85 (globe/angle), flanged, bolted bonnet, OS&Y, iron body, bronze trimmed, with body and bonnet conforming to ASTM A126 Class B cast iron. Packing and gaskets to be non-asbestos.

Check Valves: Valves shall be swing-type manufactured in accordance with MSS SP-71, Class 125, flanged ASTM A126 Class B cast iron body with bronze trim, non-asbestos gasket, or wafer-style with stainless steel SP-ring, bronze disc plates, rubber seat, body of cast iron ASTM A126 Class B or A48 for use with Class 125/150 flanges. SP-ring-actuated valve to be used on pump discharge.

SPECIAL VALVES AND HYDRANTS

Hose Bibbs: Bronze body, renewable composition disc, tee handle, 3/4" NPT inlet, 3/4" hose outlet.

Sill Faucets: Bronze body, with renewable composition disc, wheel handle, 3/4" solder inlet, 3/4" hose outlet.

Recessed Non-Freeze Wall Hydrants: Cast-bronze box, with chrome plated face, tee handle key, vacuum breaker, hinged locking cover, 3/4" inlet, and hose outlet. Bronze casing shall be length to suit wall thickness and place the shutoff control valve within the heated space.

Projecting Non-Freeze Wall Hydrants: Cast-bronze, with chrome plated face, tee handle key, vacuum breaker, 3/4" inlet, and hose outlet. Bronze casing shall be length to suit wall thickness and place the shutoff control valve within the heated space.

Floor Level Non-Freeze Hydrants: Cast-bronze hydrant, with rough bronze box, tee handle key, drain hole, vacuum breaker, hinged locking cover, 3/4" inlet, and hose outlet. Bronze casing shall be length to suit depth of bury.

Non-Freeze Post Hydrants: Cast-bronze hydrant, with tee handle key, drain hole, vacuum breaker, 3/4" inlet, and hose outlet. Bronze casing with cast-iron casing guard shall be length to suit depth of bury.

Vacuum Breaker: Each hose bibb, faucet, or hydrant shall be provided with a vacuum breaker complying with the North Carolina Plumbing Code.

Calibrated Balancing Valves: Valves, 2" and smaller, shall be suitable for 200 psi non-shock CWP at 240-deg F, with bronze or copper alloy body and calibrated ball, globe, or venturi configuration for flow control. Valve shall have integral pointer and calibrated scale to register degree of valve opening, memory stop, drain tapping, and be equipped with pressure taps for differential pressure measurement with integral check valves and seals. Valves shall be Armstrong "CBV", Bell & Gossett "Circuit Setter Plus", Griswold "Quickset", or Taco "Accu-Flo".

Reduced Pressure Backflow Preventers: Reduced pressure principle assembly consisting of shutoff valves on inlet and outlet, and strainer on inlet. Assemblies shall include test cocks, and pressure-differential relief valve located between 2 positive seating check valves, and comply with requirements of ASSE Standard 1013 and AWWA C506 and be IAPMO listed.

Double Check Valve Backflow Preventers: Backflow preventer shall be a factory-manufactured assembly shall consist of two positive seating check modules with captured springs and rubber seat discs. The check module seats and seat discs shall be replaceable. Service of all internal components shall be through a single bronze or stainless steel access cover secured with stainless steel bolts. The assembly shall include two resilient seated isolation valves; four top mounted, resilient seated test cocks. The assembly shall meet the requirements of ASSE 1015 and AWWA C510. Assembly shall be a Watts Series 007 or equivalent.

Pressure Regulating Valves: Single seated, direct acting type, having dezinctification resistant bronze body with integral or in-line strainer, and complying with requirements of ASSE Standard 1003; NSF/ANSI 372 Lead Free third party certified. Select proper size for maximum flow rate and inlet and outlet pressures indicated.

Relief Valves:

Provide proper size for relief valve, in accordance with ASME Boiler and Pressure Vessel Codes, for indicated capacity of the appliance for which installed.

Combined Pressure-Temperature Relief Valves: Bronze body, test lever, thermostat, complying with ANSI Z21.22 listing requirements for temperature discharge capacity. Provide temperature relief at 210 deg F, and pressure relief at 150 psi.

Bladder-Type Expansion Tanks: Size and number as indicated, construct of welded carbon steel for 125 psig working pressure, 240 deg F maximum operating temperature. The tank shall be designed to absorb the expansion forces of system water while maintaining proper system pressurization under varying operating conditions. Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets. Provide with pre-charged valve. Provide taps for system connection, air charging fitting (pre-charged valve), and drain fitting. Support vertical tanks with steel legs or base. Tank shall be fitted with lifting rings. Tank, with taps and supports, shall be constructed, tested, and labeled in accordance with ASME Pressure Vessel Code, Section VIII, Division 1.

PIPE ESCUTCHEONS AND FLOOR PLATES

Escutcheons: Provide steel pipe escutcheons with polished chrome finish as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any.

For waterproof floors and in areas where water and condensation can be expected to accumulate, provide brass escutcheons, one piece type with setscrew or SP-lit casting type with concealed hinge and setscrew.

In dry areas, provide stamped steel escutcheons, one piece type with spring clip fasteners or split, hinged type with spring clip fasteners.

Floor Plates: Provide floor plates as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Floor plates shall be one-piece type for new piping and split-casing type for existing piping.

DIELECTRIC UNIONS

Steel female pipe thread and copper solder joint ends conforming to dimensional, strength, and pressure requirements of ASME/ANSI B 16.39, Class 1. Steel parts shall be galvanized or plated. Union shall have a water-impervious insulation barrier capable of limiting galvanic current to one percent of the short-circuit current in a corresponding bimetallic joint. When dry, it shall also be able to withstand a 600-volt breakdown test.

WATER HAMMER ARRESTERS

Provide bellows or piston type water hammer arresters, stainless steel casing and bellows or copper casing for piston type, pressure rated for 250 psi, tested and certified in accordance with PDI Standard WH-201. Hammer arrestors shall be approved by manufacturer for installation without access required for serviceability.

THERMOMETERS

General: Provide thermometers of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.

Case: Die cast aluminum finished in baked epoxy enamel, glass front, SP-ring secured, 9" long.

Adjustable Joint: Die cast aluminum, finished to match case, 180 deg. adjustment in vertical plane, 360 deg. adjustment in horizontal plane, with locking device.

Tube and Capillary: Magnifying lens, 1% scale range accuracy, shock mounted. Mercury thermometers will not be allowed.

Scale: Satin faced, non-reflective aluminum, permanently etched markings.
Stem: Copper-plated steel, or brass, for separable socket, length to suit installation.

Range: 30 - 240 deg. F with 2 deg. F scale divisions

Thermometer Wells: Provide thermometer wells constructed of brass or stainless steel, pressure rated to match piping system design pressure. Provide 2" extension for insulated piping. Provide cap nut with chain fastened permanently to thermometer well.

PRESSURE GAGES

General: Provide pressure gages of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.

Type: General use, .05% accuracy, ANSI B40.1 grade A, phoSP-hor bronze bourdon type, bottom connection.

Case: Drawn steel or brass, glass lens, 4-1/2" diameter, glycerine filled.

Connector: Brass with 1/4" male NPT. Provide protective siphon when used for steam service.

Scale: White coated aluminum, with permanently etched markings.

Range: 0 - 100 psi

Gage Cocks: Provide pressure gage cocks between pressure gages and gage tee. Construct gage cock of brass with 1/4" female NPT on each end, and "T" handle brass plug. Include siphon fabricated from 1/4" straight coil constructed of brass tubing with 1/4" male NPT on each end and snubber, 1/4" brass bushing with corrosion resistant porous metal disc, through which pressure fluid is filtered. Select disc material for fluid served and pressure rating.

INSERTION TEST PLUGS ("Pete's Plugs")

Provide insertion test plugs pressure rated for 500 psi and 200 deg. F as indicated on the drawings. Construct of brass and finish in nickel-plate equip with 1/2" NPS fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8" O.D. probe assembly from dial type insertion pressure gage or thermometer. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.

THERMOSTATIC MIXING VALVE

ASSE 1017 certified thermostatic mixing valve with bronze body and noncorrosive internal metal parts, union or integral check stops, thermometer, mounting bracket. Valve shall maintain water temperature within 5 deg. F above setpoint and shall fail safe on loss of cold or hot water.

PART 3 - EXECUTION

PIPING APPLICATIONS

Above grade piping:

Piping 4" and smaller shall be Type L copper tubing with wrought copper fittings. Copper pipe 1-1/4” and smaller shall be soldered. Copper pipe 1-1/2” and larger shall be brazed.

Below grade connection to service water piping:

Piping 2-1/2” and smaller shall be Type K annealed soft tempered copper tubing with copper fittings wrapped in polyethylene protective covering. Copper pipe 1-1/4” and smaller shall be soldered. Copper pipe 1-1/2” and larger shall be brazed. No joints shall be used in pipe below floor slabs.

PIPING INSTALLATION

Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

Install copper tubing according to CDA's *Copper Tube Handbook*.

Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance.

Install shutoff valve immediately upstream of each dielectric fitting.

Install water-pressure-reducing valves downstream from shutoff valves.

Install domestic water piping level with 0.25 percent (approximately 1/32" per foot) slope downward toward drain, and plumb.

Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls.

Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

Install piping to permit valve servicing.

Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

Install piping free of sags and bends.

Install fittings for changes in direction and branch connections.
Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

Install pressure gages on suction and discharge piping for each plumbing pump and on inlet and outlet piping from each water heater.

Install escutcheons for piping penetrations of walls, ceilings, and floors.

Construct piping joints as follows:

Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

For brazed joints for copper tubing, comply with CDA's *Copper Tube Handbook*, "Brazed Joints" chapter.

For soldered joints for copper tubing, apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's *Copper Tube Handbook*.

For flanged Joints, select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

WATER SERVICE ENTRANCE

Extend water distribution piping to connect to water service piping, of size and in location indicated for service entrance to building in accordance with Section 221115.

Install sleeve and mechanical sleeve seal in accordance with Section 220517at penetrations through foundation wall for watertight installation.

Install shutoff valve at service entrance inside building; complete with strainer, pressure gage, and test tee with valve.

Install underground copper piping as follows:

Install piping in accordance with ANSI/AWWA C151 laying condition Type 4 **with no deflection allowed**.

Water piping shall be installed at least 30" below grade.

Construct piping joints as follows:

Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

For brazed joints for copper tubing, comply with CDA's *Copper Tube Handbook*, "Brazed Joints" chapter.

For soldered joints for copper tubing, apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's *Copper Tube Handbook*.

VALVE INSTALLATION

Except as otherwise indicated, comply with the following requirements:

Install valves where required for proper operation of piping and equipment, **including valves in branch lines to isolate sections of piping**. Locate valves so as to be accessible and so that separate support can be provided when necessary.

Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane.

Where piping is insulated, valves shall be equipped with stem extensions. On piping operating at below ambient temperature, provide a protective sleeve for stem extensions that allows operation of the valve without breaking the vapor seal or disturbing the insulation.

Swing check valves shall be installed in horizontal position, oriented with the direction of flow, with hinge pin horizontally perpendicular to center line of pipe or vertically with upward flow direction.

BACKFLOW PREVENTER INSTALLATION

Install backflow preventers per manufacturer's instructions and comply with authorities having jurisdiction.

Install drain for backflow preventers with atmospheric-vent drafting connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.

THERMOSTATIC MIXING VALVE INSTALLATION

Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet. Install per manufacturer's installation piping guidelines.

Install cabinet-type units recessed in or surface mounted on wall as specified.

INSTALLATION OF PIPING SPECIALTIES

Pipe Escutcheons: Install pipe escutcheons on each pipe penetration through floors, walls, partitions, and ceilings where penetration is exposed to view, and on exterior of building. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole, and is flush with adjoining surface.

Dielectric Unions: Install at each piping joint between ferrous and non-ferrous piping. Comply with manufacturer's installation instructions.

Water Hammer Arresters: Install in upright position, in locations and of sizes in accordance with PDI Standard WH-201, and elsewhere as indicated.

EQUIPMENT CONNECTIONS

Piping Runouts to Fixtures: Provide hot and cold water piping runouts to fixtures of sizes indicated on plans or schedule but in no case smaller than required by the Authority having Jurisdiction.

Plumbing Equipment Connections: Connect hot and cold water piping system to plumbing equipment as indicated. Provide shutoff valve and union for each connection, provide drain valve on drain connection. Arrange piping to facilitate equipment maintenance. Provide additional isolation valves and unions or flanged connections to allow piping be removed to service equipment.

FIELD QUALITY CONTROL

Inspection:

Do not enclose, cover, or put into operation water distribution piping system until it has been inspected and approved by the authority having jurisdiction.

Notify the authority having jurisdiction at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the authority.

Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.
Final Inspection: Arrange for a final inspection by the authority having jurisdiction to observe the tests specified below and to insure compliance with the requirements of the plumbing code.

Whenever the authority having jurisdiction finds that the piping system will not pass the test or inspection, make the required corrections and arrange for reinspection by the plumbing official.

Piping System Tests:

Conduct hydrostatic and leakage tests of water systems in accordance with Article 312 of the *North Carolina State Building Code: Plumbing Code.* Test for leaks and defects all new water distribution piping systems and parts of existing systems, which have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.

Leave uncovered and unconcealed all new, altered, extended, or replaced water distribution piping until it has been tested and approved. Expose all such work for testing, that has been covered or concealed before it has been tested and approved.

Cap and subject the piping system to a static water pressure of 50 psig above the operating pressure or 100 psig whichever is greater without exceeding the pressure rating of the piping system materials. Isolate the test source and allow to stand for a period of 4 hours. Leaks and loss in test pressure constitute defects that must be repaired.

Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.

Prepare reports for all tests and required corrective action.

ADJUSTING AND CLEANING

Purge all new potable water piping systems and parts of existing systems that have been altered, extended, or repaired prior to use.

Use the purging and disinfecting procedure prescribed by the authority having jurisdiction, or in case a method is not prescribed by that authority, the procedure described in either AWWA C601 or AWWA D105, or as described below:

Flush the piping system with clean, potable water until dirty water does not appear at the points of outlet for at least 10 minutes. Flush with water flowing at design flow rate. During flushing, protect fixtures with aerators as follows:

Remove aerators before flushing. After flushing, clean aerators by rinsing with clean water before replacement.

Fill the system or part thereof, with a water/chlorine solution containing at least 50 parts per million of available chlorine. Chlorinating agent shall be as selected by the Contractor and reviewed by the A/E. Acceptable chlorinating agents are calcium hypochlorite and sodium hypochlorite

Do not place chlorine tablets or powder in the piping. Placing chlorine tablets or powder in the piping is not an acceptable method of disinfection. Provide equipment and feed system for chlorinating agent that is appropriate to the chlorinating agent and the piping to be disinfected.

Isolate (valve off) the system, or part thereof, and allow to stand for 24 hours.

Drain the system, or part thereof, of the chlorinated solution, and refill with a water/chlorine solution containing at least 200 parts per million of available chlorine and isolate and allow to stand for 3 hours.

Following the allowed standing time, flush the system with clean potable water until the chlorine level in the water coming from the system does not exceed the chlorine level in the water source/supply.

After disinfection, submit samples of potable water to an independent water quality testing laboratory, certified for water quality testing by the state in which the Project is located, to conduct a bacteriological and post-chlorination tests to demonstrate compliance with the Maximum Containment Level (MCLs) of the Safe Drinking Water Act, as follows:

Total chlorine concentration not exceeding 1.0 ppm.

The absence of any coliform bacteria (0 bacteria per 100 mL sample).

Less than 200 non-coliform bacteria per 100 mL sample.

Exception: If any measure exceeds its respective MCL, test to verify that the measured concentration does not exceed the level of the Project upstream water supply/source and advise A/E of issue(s) with Project water supply/source.

In the event that testing indicates drinking water quality standards are not met, the water distribution systems shall undergo repeated disinfection, as specified above, until tests indicate compliance.

Form a protective layer on the brass in the system by turning the cold water on at all faucets in the system at one time to a "slow trickle" rate for 72 hours, continuous.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 221116

SECTION 221125 –NATURAL GAS PIPING

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specifications sections, apply to work of this section.

QUALITY ASSURANCE

Fabricate and install natural gas system in accordance with the following:

NFPA 54, *National Fuel Gas Code*

North Carolina Building Code: Fuel Gas Code.

American Gas Association: AGA

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data and installation instructions for natural gas systems materials and products.

PART 2 - PRODUCTS

PIPING MATERIALS AND PRODUCTS

Piping Materials: Provide pipe and tube of type, joint type, grade, size and weight (wall thickness or Class) indicated for each service. Where type, grade or class is not indicated, provide proper selection as determined by Installer for installation requirements, and comply with governing regulations and industry standards.

Pipe/Tube Fittings: Provide factory-fabricated fittings of type, materials, grade, class and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve or equipment connection in each case. Where not otherwise indicated, comply with governing regulations and industry standards for selections, and with pipe manufacturer's recommendations where applicable.

Above Ground Piping:

Pipe Size 2" and Smaller: Carbon steel pipe, black, Schedule 40, malleable-iron threaded fittings, Class 150.

Pipe Size 2-1/2" and Larger: Carbon steel pipe, black, Schedule 40, wrought-steel buttwelding fittings.

Carbon Steel Pipe: ASTM A53, Type E, Grade B for piping 4” and larger or ASTM A53, Type F, Grade A for piping 3” and smaller.

Malleable-Iron Threaded Fittings: ANSI B16.3, plain or galvanized as indicated.

Malleable-Iron Threaded Unions: ANSI B16.39, screwed, ANSI B1.20.1, Class 150 hexagonal stock with metal-to-metal bronze seats, plain or galvanized as indicated.

Carbon Steel Buttwelding Fittings: ASTM A234 Gr. WPB, seamless or welded, ANSI B16.9, except ANSI B16.28 for short-radius elbows and returns, rated to match connected pipe.

Forged Steel Socket Weld Fittings: ASME B16.11, Class 2000.

Pipe Nipples: Fabricated from same pipe as used for connected pipe, except do not use less than Schedule 80 pipe where length remaining unthreaded is less than 1-1/2", and where pipe size is less than 1-1/2", and do not thread nipples full length (e.g., no close-nipples).

VALVES

Ball Valves: One-piece, ASTM B 584 bronze valve with bronze trim and threaded ends, "WOG", complying with MSS SP-110. Ball shall be chrome-plated brass with bronze blowout proof stem. Seats shall be reinforced TFE; blowout proof. Provide separate packnut with adjustable-stem packing threaded ends. CWP rating shall be 600 psig.

Gas Cocks 2" and Smaller: 150 psi non-shock WOG, bronze straightway cock, flat or square head, threaded ends.

Gas Cocks 2-1/2" and Larger: MSS SP-78, 175 psi non-shock WOG, lubricated plug type, semi-steel body, single gland, wrench-operated, flanged ends.

Solenoid Valves: Aluminum body, 120 VAC, 60 Hz, Class B continuous duty molded coil, NEMA 4 coil enclosure, electrically opened/electrically closed, dual coils, normally closed, Listed and FM approved and Labeled.

Pressure Regulating Valves: Provide single stage, steel jacketed, corrosion-resistant gas pressure regulators, with atmospheric vent, elevation compensator, with threaded ends for 2" and smaller, flanged ends for 2-1/2" and larger, for inlet and outlet gas pressures, specific gravity, and volume flow indicated.

PART 3 - EXECUTION

INSTALLATION OF ABOVE GROUND PIPING

Use sealants on metal gas piping threads that are chemically resistant to natural gas. Use sealants sparingly, and apply to only male threads of metal joints.

Remove scale, cost, slag, dirt, and cutting/threading inside and outside of pipe and pipe fitting before assembly.

Plug each gas outlet, including valves, with threaded plug or cap immediately after installation and retain until continuing piping, or equipment connections are completed.

Ground gas piping electrically and continuously within project, and bond tightly to grounding connection.

Install drip-legs in gas piping where indicated, and where required by code or regulation.

Install "Tee" fitting with bottom outlet plugged or capped, at bottom of pipe risers.

Use dielectric unions where dissimilar metals are joined together.

Install piping with 1/64" per foot (1/8%) downward slope in direction of flow.

Install piping parallel to other piping, but maintain minimum of 12" clearance between gas piping and steam or hydronic piping above 200 deg. F.

Gas piping installed above inaccessible ceilings or in return air plenum ceiling spaces shall be welded, regardless of size. Valves shall not be located in such spaces unless absolutely necessary and then shall be back welded.

Concealed piping shall not be located in solid partitions. Provide continuous access panel at piping.

Gas piping other than corrugated stainless steel tubing shall be bonded to an effective ground-fault current path in accordance with Section 310, *North Carolina State Building Code: Fuel Code*.

Exposed piping shall be identified by a yellow label marked "GAS" in black letters, along with the piping system pressure. Labels shall be shall be spaced at intervals not to exceed 5 feet.

INSTALLATION OF VALVES

Provide gas cocks at connection to gas train for each gas-fired equipment item, on risers, and on branch lines where indicated on the Drawings.

Install pressure regulating valves where indicated on the Drawings. Pipe atmospheric vent to outdoors, full size of outlet. Install gas shutoff valve upstream of each pressure regulating valve.

EQUIPMENT CONNECTIONS

Connect gas piping to each gas-fired equipment item, with drip leg and shutoff gas cock. Comply with equipment manufacturer's instructions.

FIELD QUALITY CONTROL

Inspect and purge natural gas systems in accordance with NFPA 54. Submit inspection and test reports for review by A/E.

Pressure test gas piping with compressed air or dry nitrogen to a pressure of 40 psig for a period of not less than 10 minutes. During the test period, no drop in pressure is permitted. Provide written certification of satisfactory testing.

SPARE PARTS

Furnish to Owner, with receipt, 2 valve wrenches for each type of gas cock installed.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 221125

SECTION 221316 – SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

SCOPE

The work defined by this section includes sanitary drain, waste, and vent piping beginning at each plumbing fixture connection within the building. Vents shall extend through the roof, while drain and waste piping shall extend 10' beyond the walls of the building.

Roof drains, connections to roof drains and drainage piping from the roof drains, extending to 10' beyond the walls of the building shall be provided under Section 221416.

QUALITY ASSURANCE

ANSI Compliance: Comply with applicable ANSI standards pertaining to materials, products, and installation or soil and waste systems.

ASSE Compliance: Comply with applicable ASSE standards pertaining to materials, products, and installation of soil and waste systems.

PDI Compliance: Comply with applicable PDI standards pertaining to products and installation of soil and waste systems.

Piping Identification: Each length of pipe and pipe fitting, trap, etc. installed as part of a plumbing system shall bear the identification of the manufacturer and the applicable standard to which it was manufactured.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data for soil waste systems materials and products.

Inspection Reports: Submit copies of field inspection reports required by Part 3.

PART 2 - PRODUCTS

SANITARY PIPES AND PIPE FITTINGS

Piping Materials: Provide pipe and tube of type, joint type, grade, size and weight (wall thickness or Class) indicated for each service. Where type, grade or class is not indicated, provide proper selection as determined by Installer for installation requirements, and comply with governing regulations and industry standards.

Pipe/Tube Fittings: Provide factory-fabricated fittings of type, materials, grade, class and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve or equipment connection in each case. Where not otherwise indicated, comply with governing regulations and industry standards for selections, and with pipe manufacturer's recommendations where applicable.

Above Ground Piping:

Pipe Size 1 1/2" and Smaller: Copper DWV tube and drainage fittings, ASTM B 306 drawn temper tube, ASME B16.29, wrought copper solder-joint fittings.

Pipe Size 2" and Larger: Hubless cast-iron soil pipe and fittings, Service class. Conform to CISPI Standard 301/ASTM A 888, Service class, with heavy duty neoprene rubber/stainless steel couplings conforming to CISPI 310/ASTM C1540. For pipe sizes 1-1/2" through 4", couplings shall have a minimum four (4) bands and for pipe sizes 5" through 15", provide minimum six (6) bands.

Below Ground Piping:

Pipe Size 15" and Smaller: Cast-iron hub-and-spigot soil pipe and fittings, Service class. Joints may be sealed with lead and oakum or with neoprene gaskets complying with CISPI Standard 310/ASTM C 564.

Lead/Oakum Joint Materials: Provide ASTM B 29 lead with oakum or hemp fiber caulking.

CORROSION-RESISTANT PIPES AND PIPE FITTINGS

Polypropylene Pipe, Type PP-DWV (only use in Non-plenum ceilings and below grade): Polypropylene drain, waste, and vent piping shall be products manufactured from Type I-19509, black olefin resins conforming to ASTM D4101and tested in accordance with applicable provisions of ASTM D2447. Comply with applicable provisions of ASME B16.12 for material dimensions and configurations. Provide only PP materials specifically suitable for joining interfaces into a homogeneous mass by fusion at high temperatures, with molded threaded assemblies. **No thread cutting is permitted** Ensure pipe-wall thickness is Schedule 40 with minimum burst pressure when tested in accordance with ASTM D6927 for 60 to 90 seconds as follows:

Size (inches)	1-1/2	2	3	4
Burst Pressure (psig)	665	550	530	450

Fittings for Corrosion Resistant Pipe: Provide fittings matching pipe, and with equal-or-better acid resistance; comply with same standards where applicable. Unless otherwise indicated, provide fittings produced by manufacturer of pipe, and recommended for service indicated.

PIPING SPECIALTIES

Drains: Provide drains as indicated on the Drawings, as follows:

Bodies shall be cast iron with wall thickness not less than 1/4" and with tops of nickel-bronze, chrome plated bronze, or cast iron, as indicated on Drawings or as herein specified. Castings shall be gray cast iron or ductile iron and shall be smooth and well cleaned inside and out, with all fins and roughness removed, and provided with the manufacturer's standard protective coating or other protective coating indicated or specified.

All drains installed above grade and in connection with waterproofed floors shall be equipped with a clamping device. When drains are installed with metal waterproofing, the metal shall be clamped, caulked, or soldered watertight to the drain.

All drains shall be provided with traps either integral with drain body or separate, except where otherwise indicated or specified.

Backwater Valves: In accordance with ASME A112.14.1, gray-iron body and bolted cover, with bronze seat. Valves shall be horizontal type with swing chek valve and hub-and-spigot ends.

Cleanouts and Access Covers: Provide as follows; equivalent products manufactured by Josam or Zurn will be acceptable:

Cleanouts in Floors: J. R. Smith No. 4100 caulking ferrule with satin finish, nickel-bronze, scoriated access cover in finished area and bronze scoriated top in storage and similar unfinished areas.

Cleanouts in Walls: J. R. Smith No. 4020 ferrule with No. 4710 satin finish chrome plated brass or stainless steel round access cover secured to plug by a countersunk brass screw in finished areas and satin finish brass cover in unfinished storage and similar habitable unfinished areas.

Cleanout Plugs: Cast-bronze or brass, threads complying with ANSI B2.1, countersunk head.

Flashing Flanges: Cast-iron watertight stack or wall sleeve with membrane flashing ring. Provide underdeck clamp and sleeve length as required.

Vent Flashing Sleeves: Cast-iron caulking type roof coupling for cast-iron stacks, cast-iron threaded type roof coupling for steel stacks, and cast-bronze stack flashing sleeve for copper tubing.

Trap Primers: Provide bronze trap primer valve with automatic vacuum breaker, complying with ASSE 1018, with 1/2" connections matching mating piping system.

Electronic Trap Primer: Electronic, automatic trap priming assembly capable of priming multiple floor drains every 24 hours by a timed discharge of water, supplying at least 2 oz. of water at 20 psig. Unit shall consist of ball valve stop, UL listed solenoid valve, atmospheric anti-siphon vacuum breaker, fused electrical control with timer, UL transformer where required, manual override/test switch, type L copper tubing manifold with the required quantity of ½" copper outlet connections. Components shall be housed within a NEMA-1 galvanized steel cabinet with cover plate, suitable for surface or recessed mounting as required. Unit shall be ASSE 1044 certified and operate with a power supply of 120V/60 Hz/1 Ph. Unit shall be as manufactured by Precision Plumbing Products, Zurn Industries, Sioux Chief Mfg. Co. or Mifab, Inc.

ACID WASTE NEUTRALIZING TANKS

Where indicated on the Drawings, provide acid waste neutralizing tank constructed of HDPE or ASTM D 4101 polypropylene with removable, gastight cover, sidewall inlet and outlet piping connections, and vent connection in sidewall or top. Acid neutralization media shall be limestone chips or lumps with more than 90 percent calcium carbonate content and 1- to 3-inch diameter.

Tanks shall be sized on the basis of the number of fixtures connected to it, as follows:

Number of Connected Fixtures	Basin Dimensions	
	Diameter (in.)	Height (in.)
1	12	12
2	18	12
3-6	18	24
7-20	24	36
21-50	30	57
51-100	36	70

Pipe discharge from tank to sanitary drain.

PART 3 - EXECUTION

INSTALLATION OF DRAIN, WASTE, AND VENT PIPING

Lay underground building drains beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Clean interior of piping of dirt and other superfluous material as work progresses. Maintain swab or drag in line and pull past each joint as it is completed. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

Install soil and vent piping pitched to drain at minimum slope of 1/4" per foot (2%) for piping 2-1/2" and smaller, and 1/8" per foot (1%) for piping 3" and larger.

Make changes in direction for drainage and vent piping using appropriate 45-degree wyes, half-wyes, or long sweep quarter, sixth, eighth, or sixteenth bends. Sanitary tees or short quarter bends may be used on vertical stacks of drainage lines where the change in direction of flow is from horizontal to vertical, except use long-turn tees where two fixtures are installed back to back and have a common drain. Straight tees, elbows, and crosses may be used on vent lines.

No change in direction of flow greater than 90 degrees shall be made.

Where different sizes of drainage pipes and fittings are connected, use proper size, standard increasers and reducers. Reduction of the size of drainage piping in the direction of flow is prohibited.

Fabricate steel pipe nipples from same pipe as used for connected pipe. Use Schedule 80 pipe for nipple fabrication where unthreaded length is less than 1-1/2" or where pipe size is less than 1-1/2" NPS. **Do not thread nipples full length, "close" nipples are prohibited.**

Install backwater valves in sanitary building drain piping as indicated on the Drawings or required. For interior installation, provide cleanout cover flush to floor centered over backwater valve cover, and of adequate size to remove valve cover for service.

Install cleanouts in above ground piping and building drain piping as indicated or required and at each change in direction of piping greater than 45 deg.; at minimum intervals of 50' for piping 4" and smaller and 80' for larger piping; and at base of each vertical soil or waste stack. Install floor and wall cleanout covers for concealed piping, select type to match adjacent building finish. Install cleanouts at the base of all waste risers.

Install flashing flange and clamping device with each stack and cleanout passing through waterproof membranes.

Install vent flashing sleeves on stacks passing through roof, secure over stack flashing in accordance with manufacturer's instructions.

Where waste piping passes through fire rated walls, partitions, ceilings, or floors, maintain the fire rated integrity in accordance with Section 019913.

INSTALLATION OF FLOOR DRAINS

Install floor drains in accordance with manufacturer's written instructions and in locations indicated so as to drain the entire floor or that portion of the floor allocated to it.

Coordinate flashing work with work of waterproofing and adjoining substrate work.

Coordinate with soil and waste piping as necessary to interface floor drains with drainage piping systems.

Install floor drains at low points of surface areas to be drained, or as indicated. Set tops of drains flush with finished floor.

Install drain flashing collar or flange so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.

Position drains so that they are accessible and easy to maintain.

Protect drains after installation to avoid clogging with construction materials and debris, and to prevent damage from traffic and construction work.

INSTALLATION OF TRAP PRIMERS

Install trap primers as indicated, and in accordance with manufacturer's installation instructions. Pitch piping toward drain trap, minimum of 1/8" per foot (1%). Adjust trap primer for proper flow.

EQUIPMENT CONNECTIONS

Provide drain and waste piping runouts to plumbing fixtures and drains, with approved trap, of sizes indicated, but in no case smaller than required by *North Carolina State Building Code: Plumbing Code*.

Piping connections to roof drains shall be made with neoprene gasket provided for caulk type drains. Expansion joints where indicated or required shall be Josam Series 26200 or equivalent of size to match pipe.

Locate piping runouts as close as possible to bottom of floor slab supporting fixtures or drains.

FIELD QUALITY CONTROL

Inspections by the Authority Having Jurisdiction:

Do not enclose, cover, or put into operation drainage and vent piping system until it has been inspected and approved by the authority having jurisdiction.

During the progress of the installation, notify the authority having jurisdiction, at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.

Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.

Final Inspection: Arrange for a final inspection to observe the tests specified below and to insure compliance with the requirements of the plumbing code.

Whenever the piping system fails to pass the test or inspection, make the required corrections, and arrange for it to be reinspected by the authority.

Submit copies of written inspection reports, signed by the authority having jurisdiction, immediately following testing to the A/E for review.

Hydrostatic and Leakage Tests:

Conduct hydrostatic and leakage tests soil and waste systems in accordance with Article 312 of the North Carolina State Building Code: Plumbing Code.

When leakage or pressure drop exceeds the allowable amount specified, make repairs/ corrections and retest. Correct visible leaks regardless of leakage test results.

Submit written reports of all hydrostatic and/or leakage tests immediately following testing to the A/E for review.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 221316

SECTION 221416 – STORM WATER PIPING

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

SCOPE

Roof drains and connections to roof drains and drainage piping from roof drains, extending to 10' beyond the walls of the building shall be provided under this section.

QUALITY ASSURANCE

ANSI Compliance: Comply with applicable ANSI standards pertaining to materials, products, and installation or soil and waste systems.

ASSE Compliance: Comply with applicable ASSE standards pertaining to materials, products, and installation of soil and waste systems.

PDI Compliance: Comply with applicable PDI standards pertaining to products and installation of soil and waste systems.

Piping Identification: Each length of pipe and pipe fitting, trap, etc. installed as part of a plumbing system shall bear the identification of the manufacturer and the applicable standard to which it was manufactured.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data for soil waste systems materials and products.

Inspection Reports: Submit copies of field inspection reports required by Part 3.

PART 2 - PRODUCTS

PIPES AND PIPE FITTINGS

Piping Materials: Provide pipe and tube of type, joint type, grade, size and weight (wall thickness or Class) indicated for each service. Where type, grade or class is not indicated, provide proper selection as determined by Installer for installation requirements, and comply with governing regulations and industry standards.

Pipe/Tube Fittings: Provide factory-fabricated fittings of type, materials, grade, class and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve or equipment connection in each case. Where not otherwise indicated, comply with governing regulations and industry standards for selections, and with pipe manufacturer's recommendations where applicable.

Above Ground Piping:

Pipe Size 1 1/2" and Smaller: Copper DWV tube and drainage fittings; ASTM B 306 drawn temper tube, ASME B16.29, wrought copper solder-joint fittings.

Pipe Size 2" and Larger: Hubless cast-iron soil pipe and fittings, Service class. Conform to CISPI Standard 301/ASTM A 888, Service class, with heavy duty neoprene rubber/stainless steel couplings conforming to ASTM C1540. For pipe sizes 1-1/2" through 4", couplings shall have a minimum four (4) bands and for pipe sizes 5" through 15", provide minimum six (6) bands.

Below Ground Piping:

Pipe Size 15" and Smaller: Cast-iron hub-and-spigot soil pipe and fittings, Service class. Joints may be sealed with lead and oakum or with neoprene gaskets complying with CISPI Standard 310/ASTM C 564.

Lead/Oakum Joint Materials: Provide ASTM B 29 lead with oakum or hemp fiber caulking.

PIPING SPECIALTIES

Cleanouts and Access Covers: Provide as follows; equivalent products manufactured by Josam or Zurn will be acceptable:

Cleanouts in Floors: J. R. Smith No. 4100 caulking ferrule with satin finish, nickel-bronze, scoriated access cover in finished area and bronze scoriated top in storage and similar unfinished areas.

Cleanouts in Walls: J. R. Smith No. 4420 ferrule with No. 4710 satin finish chrome plated brass or stainless steel round access cover secured to plug by a countersunk brass screw in finished areas and satin finish brass cover in unfinished storage and similar habitable unfinished areas.

Cleanout Plugs: Cast-bronze or brass, threads complying with ANSI B2.1, countersunk head.
Flashing Flanges: Cast-iron watertight stack or wall sleeve with membrane flashing ring. Provide underdeck clamp and sleeve length as required.

PART 3 - EXECUTION

INSTALLATION OF STORM DRAIN PIPING

Install above ground piping plumb and square with building structure, supported both horizontally and vertically in accordance with Section 220529. Construct piping joints as follows:

Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

Lay underground drain piping beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Clean interior of piping of dirt and other superfluous material as work progresses. Maintain swab or drag in line and pull past each joint as it is completed. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

Install piping pitched to drain at minimum slope of 1/4" per foot (2%) for piping 2-1/2" and smaller, and 1/8" per foot (1%) for piping 3" and larger.

Make changes in direction using appropriate 45-degree wyes, half-wyes, or long sweep quarter, sixth, eighth, or sixteenth bends. Sanitary tees or short quarter bends may be used on vertical stacks of drainage lines where the change in direction of flow is from horizontal to vertical, except use long-turn tees where two fixtures are installed back to back and have a common drain. Straight tees, elbows, and crosses may be used on vent lines.

No change in direction of flow greater than 90 degrees shall be made.

Where different sizes of drainage pipes and fittings are connected, use proper size, standard increasers and reducers. Reduction of the size of drainage piping in the direction of flow is prohibited.

Fabricate steel pipe nipples from same pipe as used for connected pipe. Use Schedule 80 pipe for nipple fabrication where unthreaded length is less than 1-1/2" or where pipe size is less than 1-1/2" NPS. **Do not thread nipples full length, "close" nipples are prohibited.**

Install cleanouts as indicated or required and at each change in direction of piping greater than 45 deg.; at minimum intervals of 50' for piping 4" and smaller and 80' for larger piping; and at base of each roof drain leader. Install floor and wall cleanout covers for concealed piping, select type to match adjacent building finish. Install cleanouts at the base of all piping risers.

Where drain piping passes through fire rated walls, partitions, ceilings, or floors, maintain the fire rated integrity in accordance with Section 019913.

FIELD QUALITY CONTROL

Inspections by the Authority Having Jurisdiction:

Do not enclose, cover, or put into operation drainage piping system until it has been inspected and approved by the authority having jurisdiction.

During the progress of the installation, notify the authority having jurisdiction, at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.

Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.

Final Inspection: Arrange for a final inspection to observe the tests specified below and to insure compliance with the requirements of the plumbing code.

Whenever the piping system fails to pass the test or inspection, make the required corrections, and arrange for it to be reinspected by the authority.

Submit copies of written inspection reports, signed by the authority having jurisdiction, immediately following testing to the A/E for review.

Hydrostatic and Leakage Tests:

Conduct hydrostatic and leakage tests in accordance with Article 312 of the *North Carolina State Building Code: Plumbing Code*.

When leakage or pressure drop exceeds the allowable amount specified, make repairs/ corrections and retest. Correct visible leaks regardless of leakage test results.

Submit written reports of all hydrostatic and/or leakage tests immediately following testing to the A/E for review.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 221416

SECTION 223300 – ELECTRIC DOMESTIC WATER HEATERS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Construct water heaters in accordance with the following UL standards:

UL 174, *Household Electric Storage-Tank Water Heaters*

UL 499, *Electric Heating Appliances*

UL 1261, *Electric Water Heaters for Pools and Tubs*

UL 1453, *Electric Booster and Commercial Storage Tank Water Heaters*

NSF Compliance: Construct and install water heaters located in food service establishments in accordance with NSF 5, *Standard for Hot Water Generating Equipment for Food Service Establishments using Spray Type Dishwashing Machines*.

NEC Compliance: Install electric water heaters in accordance with requirements of NFPA 70, *National Electrical Code* (NEC).

NSF Labels: Provide water heaters that are listed and labeled by National Sanitation Foundation.

ASME Code Symbol Stamps: Provide water heaters and safety relief valves that comply with ASME Boiler and Pressure Vessel Code, and are stamped with appropriate code symbols.

North Carolina Building Code Compliance: Electric hot water heaters shall meet or exceed the minimum efficiency rating required by the *North Carolina State Building Code: Energy Conservation Code,* Table 504.2

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data including rated capacities and efficiencies of selected model clearly indicated, operating weights, furnished specialties and accessories, and installation and start-up instructions.

Certificates: Submit appropriate Certificates of Shop Inspection and Data Report as required by provisions of ASME Boiler and Pressure Vessel Code. Arrange Labor Department inspection of all pressure vessels, and provide certificate for each vessel in a sturdy glass frame on wall adjacent to equipment.

PART 2 - PRODUCTS

COMMERCIAL ELECTRIC WATER HEATERS

General: Provide commercial quality electric water heaters of sizes, capacities, and electrical characteristics as indicated.

Heater: Working pressure of 150 PSI, magnesium anode rod; glass lining on internal surfaces exposed to water.

Heating Elements: Heavy-duty, medium watt density, with incoloy sheath, thermostat stepped through magnetic contactors.

Safety Controls: Double pole, manual reset, high limit, probe type electric low water cutoff, both factory wired.

Jacket: Equip with full size control compartments with front panel opening. Insulate tank with vermin-proof glass fiber insulation. Provide outer steel jacket with bonderized undercoat and baked enamel finish.

Accessories: Provide brass drain valve, 3/4" temperature and pressure relief valve, ASME tank construction for 125 PSI working pressure, and 4" x 6" hand hole cleanout.

Controls: Adjustable immersion thermostat, power circuit fusing, pilot light and switch controlling control circuit, 3-stage time delay sequencer, and 7-day time clock.

DI ELECTRIC TANKLESS WATER HEATERS

General: Provide commercial quality electric tankless water heaters of sizes, capacities, and electrical characteristics as indicated. Stainless steel, Nichrome and Engineered plastics for all wetted components.

Heater: Working pressure of 150 PSI, Stainless steel connections for deionized water, without storage capacity. Capable of heating high purity water up to levels of 18 MEG OHM.

Heating Elements: Resistance heating system.

Safety Controls: Double pole, manual reset, high limit- low water cutoff, both factory wired. Thermostatic temperature control with +- 1°F temperature stability.

Enclosure: Equip with front panel opening. Provide aluminum or steel jacket with bonderized undercoat and baked enamel finish.

Support: Bracket for wall mounting.

Controls: Thermostat, Manifold controller for multiple units.

PART 3 - EXECUTION

INSTALLATION OF WATER HEATERS

Install water heaters in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

Place heaters on concrete pads, orient so controls and devices needing service and maintenance have adequate access.

Connect hot and cold water piping to units with shutoff valves and unions. As applicable, connect recirculating water line with shutoff valve, check valve, and union. Extend relief valve discharge to closest floor drain, to drain pan, or as indicated on the Drawings.

Drain pan shall installed where water heater is installed in remote locations such as above a suspended ceiling, in an attic, above occupied spaces, or in unventilated crawls spaces and/or where damage to building construction elements may result from a water release. The drain pan shall be at least at least 1-1/2" deep, be unobstructed by the heater, and be constructed of minimum **20 gauge** G90 galvanized sheet metal. Provide minimum 1" NPS drain from pan to storm water drain.

FIELD QUALITY CONTROL

Start-up, test, and adjust electric water heaters in accordance with manufacturer's start-up instructions. Check and calibrate controls.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 223300

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Where indicted by "ADA/H-C" compliance requirement, plumbing fixtures and their installation shall comply with the *Americans with Disabilities Act Architectural Guidelines* (ADAAG).

Comply with the following applicable standards and other requirements specified for water coolers:

ASHRAE Standard 18

ARI Standard 1010

UL Standard 399

Comply with the following applicable standards and other requirements specified for plumbing fixtures:

Enameled, Cast-Iron Fixtures: ASME A112.19.1M.

Plastic Mop-Service Basins: ANSI Z124.6.

Plastic Shower Enclosures: ANSI Z124.2.

Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.

Slip-Resistant Bathing Surfaces: ASTM F 462.

Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.

Stainless-Steel Commercial, Handwash Sinks: NSF 2 construction.

Vitreous-China Fixtures: ASME A112.19.2M.

Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.

Water-Closet, Flushometer Tank Trim: ASSE 1037.

Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.

Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.

Diverter Valves for Faucets with Hose Spray: ASSE 1025.

Faucets and Stops: ASME A112.18.1, NSF/ANSI 61.

Hose-Connection Vacuum Breakers: ASSE 1011.

Hose-Coupling Threads: ASME B1.20.7.

Integral, Atmospheric Vacuum Breakers: ASSE 1001.

Sensor-Actuated Faucets and Electrical Devices: UL 1951.

Comply with the following applicable standards and other requirements specified for bathtub/shower faucets:

Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.

Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.

Deck-Mounted Bath/Shower Transfer Valves: ASME 18.7.

Hand-Held Showers: ASSE 1014.

High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.

Manual-Control Antiscald Faucets: ASTM F 444.

Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.

Sensor-Actuated Faucets and Electrical Devices: UL 1951.

Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.

Comply with the following applicable standards and other requirements specified for the following plumbing fixture elements:

Atmospheric Vacuum Breakers: ASSE 1001.

Brass and Copper Supplies: ASME A112.18.1.

Disposers: ASSE 1008 and UL 430.

Dishwasher Air-Gap Fittings: ASSE 1021.

Flexible Water Connectors: ASME A112.18.6.

Floor Drains: ASME A112.6.3.

Flushometers, Manual-Operation : ASSE 1037.

Flushometers, Sensor-Operation: ASSE 1037 and UL 1951.

Grab Bars: ASTM F 446.

Hose-Coupling Threads: ASME B1.20.7.

Hot-Water Dispensers: ASSE 1023 and UL 499.

Off-Floor Fixture Supports: ASME A112.6.1M.

Plastic Shower Receptors: ANSI Z124.2.

Plastic Toilet Seats: ANSI Z124.5.

Supply and Drain Protective Shielding Guards: ICC A117.1.

Whirlpool Bathtub Equipment: UL 1795.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not comply fully with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturers Data: Submit Manufacturers Data and Installation instructions for each fixture, faucet, specialties, accessories, and trim specified; clearly indicate rated capacities of selected models of water coolers.

Color Charts: Submit manufacturer's standard color charts for cabinet finishes and fixture colors.

DELIVERY, STORAGE, AND HANDLING

Store fixtures where environmental conditions are uniformly maintained within the manufacturer's recommended temperatures to prevent damage.

Store fixtures and trim in the manufacturer's original shipping containers. Do not stack containers or store in such a manner that may cause damage to the fixture on trim.

EXTRA STOCK

Furnish special wrenches and other devices necessary for servicing plumbing fixtures and trim to Owner with receipt in a quantity of one device for each ten fixtures.

Furnish faucet repair kits complete with all necessary washers, springs, pins, retainers, packings, O-rings, sleeves, and seats in a quantity of one kit for every forty faucets.

PART 2 - PRODUCTS

FIXTURES

Fixtures shall be provided as scheduled on the Drawings. Outfits shall be complete and shall include fixture and all required appurtenances, trim and fittings to provide a complete matched installation.

Acceptable Manufacturers: Subject to compliance with requirements, provide plumbing fixtures of one of the following:

Plumbing Fixtures: Earthenware vitreous china or enameled cast iron shall be Zurn; American Standard; U.S. Plumbing Products Kohler Co.; Eljer; Crane; Sloan Valve Co. or Toto USA.

Fixture Seats: Beneke Corporation Bemis Seats; Forbes-Wright Industries, Inc. Church Products; or Olsonite Corporation.

Hand Wash Fountains: Bradley Corporation; Acorn Mfg. Co.; or Metcraft

Water Coolers: Elkay Mfg. Co.; Halsey Taylor Div., Household International Co.; Haws Drinking Faucet Co.; or Oasis

Stainless Steel Sinks: Elkay Mfg. Co.; Just Mfg. Co.; American Standard; Kohler; or Franke Commercial.

Shower Bath Equipment: Aquarius; Aqua-Bath; Aqua-Glass; or Fiat

Thermostatic Mixing Valves: Armstrong; Bradley; Leonard; Powers; or Symmons.

Shower Valves: Symmons; Leonard Valve Co; Powers; or Lawler.

Sink and Lavatory Faucets: Zurn Commercial; Moen Commercial; Chicago Faucets; Delta Commercial (Tek Institutional); Sloan Valve Co.; Symmons Industries, Inc.; or T&S Brass and Bronze works, Inc.

Flush Valves: Sloan Valve Co.; Delta Commercial (Tek Institutional); Toto USA; Delany Products or Zurn Industries, Inc.

Fixture Carriers: Josam Mfg. Co.; Wade Division/Tyler Pipe; Zurn Industries, Inc., Hydromechanics Div.; or Jay R. Smith Mfg. Co.

Emergency Care Fixtures and Equipment: Haws Mfg. Co.; Guardian Equipment; Western Safety Equipment Co.; WaterSaver or Bradley Corporation.

Floor Drains and Sinks: Josam Mfg. Co.; Zurn Industries, Inc., Hydromechanics Div.; Jay R. Smith Mfg. Co.; Wade; Watts Regulator Co.; or Mifab, Inc.

Mop Service Basins: Fiat Products; E.L. Mustee & Sons, Inc.; Florestone Inc.

Materials:

Provide materials which have been selected for their surface flatness and smoothness. Exposed surfaces which exhibit pitting seam marks, roller marks, foundry sand holes, stains, discoloration, or other surface imperfections on finished units are not acceptable.

Where fittings, trim and accessories are exposed or semi-exposed provide bright chrome-plated or polished stainless steel units. Provide copper or brass where not exposed.

Stainless Steel Sheets: ASTM A167, Type 302/304, hardest workable temper with No. 4, bright finish, directionally polished on exposed surfaces.

Steel Sheets for Baked Enamel Finish: ASTM A 591, coating Class C, galvanized-bonderized.

Steel Sheets for Porcelain Enamel Finish: ASTM A 424, commercial quality, Type 1.

Galvanized Steel Sheet: ASTM A 526, except ASTM A 527 for extensive forming; ASTM A 525, G90 zinc coating, chemical treatment.

Aluminum: ASTM B 209/B 221 sheet, plate, and extrusions, as indicated; alloy, temper and finish as determined by manufacturer, except 0.40 mil natural anodized finish on exposed work unless another finish is indicated.

Vitreous China: High quality, free from fire cracks, spots, blisters, pinholes and specks; glaze exposed surfaces, and test for crazing resistance in accordance with ASTM C554.

Shower Valves and Faucets:

Heavy duty cast brass or machined brass construction, pressure balancing, unless otherwise specified, with integral check stops and chrome plated brass face plate or escutcheon. Refer to plans for accessories.

Water Coolers:

Wall Hung Water Cooler: Factory assembled and tested, listed and labeled in compliance with UL Standard 399, with capacities rated in accordance with ASHRAE Standard 18, and ARI Standard 1010.

Cabinet: Heavy gauge welded steel cabinet, with satin finish stainless steel front panel and hanger bracket for wall mounting.

Top: Deep basin, anti-splash, smoothly contoured stainless steel with raised bubbler mount, chrome plated brass strainer, and 1-1/4" tailpiece.

Bubbler and Valve: Chrome plated brass, automatic stream control, push-button valve with bubbler designed to provide uniform stream without spurting.

Refrigeration System: Refrigerant R-134a, hermetically sealed, capillary tube. All joints silver soldered.

Compressor: Hermetically sealed, with automatic reset overload protection.

Condenser: Air-cooled

Cooling Unit: Tube type, self-cleaning, continuous coil of seamless copper.

Temperature Control: Thermostat with adjustable range of 42 deg. F to 53 deg. F.
Electrical Characteristics: 120 V, 60 Hz, 1/5 HP, provide 3-prong power lead-in cord.

Capacity: 8.2 GPH of 50 deg. F water, with ambient temperature of 90 deg. F. and 80 deg. F entering water temperature.

Connections: Provide trap, and supply with stop valve as specified below.

Wall Hung ADA/H-C Water Cooler: Shall be factory assembled and tested, listed and labeled in compliance with UL Standard 399, and have capacities rated in accordance with ASHRAE Standard 18, and ARI Standard 1010. Water cooler shall fully comply with heights and clearances required by Fig. 27A of the ADAAG.

Receptor: 18 gauge, type 304, stainless steel ASTM A-167, with No. 4 finish ASTM A-480 on the outside.

Waste: Concealed 1-1/4" O.D. tailpiece, chrome plated waste strainer and 1-1/4" I.P.S. trap.

Supply: ½" I.P.S. screwdriver stop.

Grille: Stainless steel, one-piece louvered grille matching receptor.

Refrigeration System: Refrigerant R-134a, hermetically sealed, capillary tube. All joints silver soldered.

Compressor: Hermetically sealed, with automatic reset overload protection.

Condenser: Air-cooled

Cooling unit: Tube type, self-cleaning, continuous coil of seamless copper.

Temperature Control: Thermostat with adjustable range of 42 deg. F. to 53 deg F.

Electrical Characteristics: 120 V, 60 Hz, 1/5 HP, provide 3-prong power lead-in cord.

Capacity: 8.0 GPH of 50 deg. F water, with ambient temperature of 90 deg. F, and 80 deg. F entering water temperature.

Connections: Provide p-trap and supply with stop valve as specified below.

Plumbing Fittings, Trim and Accessories:

Water Outlets: At locations where water is supplied (by manual, automatic or remote control), provide commercial quality faucets, valves, or dispensing devices, of type and size scheduled on the Drawings, and as required to operate as indicated. Include manual shutoff valves and connecting stem pipes to permit outlet servicing without shut-down of water supply piping systems.

Automatic Faucets:

Mechanical-Operated Faucets: Actuation of faucet "on" shall be manual. Integral adjustable spring or piston actuator shall turn faucet "off".

Sensor-Operated Faucets: Actuation of faucet shall be via solenoid controlled by a battery-powered or hardwired, dual beam infrared or multi-spectrum electronic sensor; adjustable cycles.

Vacuum Breakers: Provide with flush valves where required by governing regulations, including locations where water outlets are equipped for hose attachment.

P-traps: Where drains are indicated for direct connection to drainage system, provide heavy cast brass body p-traps with cleanout plugs, all chrome plated where exposed to view.

Escutcheons: Where fixture supplies and drains penetrate walls in exposed locations, provide escutcheons with set screw in accordance with Section 221116.

Aerators: Provide Laminar flow aerator for all faucets.

Fixture Accessories, Appurtenances and Trim:

Flush Valves:

Manual flush valves shall be metal lever handle operated diaphragm controlled flush valve with angle stop valve, vacuum breaker flush tube assembly, solid ring flush tube support, sweat solder adaptor, set screw secured cast brass pipe escutcheon, and nipple cover tubes, all parts entirely heavy chrome plated. Furnish and install trap primer kit flush tubes where indicated or required. Flush valve features shall include quiet operation adjustable type large diaphragm, non-siphon by-pass, non-drip handle seal and non-hold open. Valves shall be rated as follows:

Standard: Maximum 1.6 gal/flush

High Efficiency: Maximum 1.28 gal/flush

Manual, dual operation flush valves shall be metal lever handle operated diaphragm controlled flush valve with angle stop valve, vacuum breaker flush tube assembly, solid ring flush tube support, sweat solder adaptor, set screw secured cast brass pipe escutcheon, and nipple cover tubes, all parts entirely heavy chrome plated. Furnish and install trap primer kit flush tubes where indicated or required. Flush valve features shall include quiet operation adjustable type large diaphragm, non-siphon by-pass, non-drip handle seal and non-hold open. Valves shall be rated as follows:

Liquids Only Flush (handle up): Maximum 0.8 gal/flush

Liquids and Solids Flush (handle down): Maximum 1.6 gal/flush

Sensor-operated flush valves shall be diaphragm controlled flush valve with angle stop valve, vacuum breaker flush tube assembly, solid ring flush tube support, sweat solder adaptor, set screw secured cast brass pipe escutcheon, and nipple cover tubes, all parts entirely heavy chrome plated. Furnish and install trap primer kit flush tubes where indicated or required. Flush valve features shall include quiet operation adjustable type large diaphragm, non-siphon by-pass, non-drip handle seal and non-hold open. Sensor-operated flush valves shall be battery powered or hard wired as indicated on the drawings. Valves shall be rated as follows:

	Maximum Water Consumption	
Application	**Standard**	**High Efficiency**
Water Closet	1.6 gal/flush	1.28 gal/flush
Urinal	1.0 gal/flush	0.25 gal/flush

Actuation of valve shall be via solenoid controlled by a dual beam infrared or multi-spectrum electronic sensor.

Where hard wired sensor operated flush valves and/or faucets are indicated on the drawings, provide and install appropriately sized U.L. listed Class II transformer(s) compatible with the voltage and power requirements of the valves and faucets. Install transformers where shown on the drawings and provide toggle disconnect switch and all conduit, outlet boxes and wiring required for a complete installation.

Water Closet Seats: Seats shall be heavy duty white solid plastic with self sustaining check hinges, enclosed stainless steel or brass hinge posts and matching locknuts and washers. Generally, seats shall be non-contour type, open front elongated less cover and with integral bumpers. Refer to fixture fixture schedule on the Drawings for required variations to include closed front, round bowl type, cover and color.

Fixture Stops and Supply Piping: Generally, heavy angle pattern brass loose key stops with replaceable chlorine or chloramine resistant washers or (ball valve type), all heavy chrome plated, shall be furnished and installed for all lavatories, flush tank water closets and where piping is exposed below sinks. Angle or straight pattern stops and stops integral with faucets and exposed or concealed valve (shower or bath) shall be provided where specified and/or indicated. Supplies shall be 1/2" IPS pipe or sweat x compression, with chrome plated flexible copper risers, unless otherwise specified, 1/2" chrome plated cast brass nipples or 1/2" chrome plated copper extension tubes and chrome plated brass flanges. Stops shall be as manufactured by McGuire, Brass Craft, Dearborn Brass, Keeney Manuf. Co., Zurn, or Chicago Faucet.

Fixture waste outlet, tailpiece, overflow and waste assembly piping and fittings:

Bathtub: Waste and overflow shall be minimum 17 gauge x 1-1/2" diameter brass tubing with cast brass fittings (concealed) and chrome plated cast brass for exposed parts. Stop assembly shall be trip lever with flat chrome plated brass strainer. P-traps shall not be installed underground.

Lavatory: Unless otherwise specified on drawings, lavatory waste outlet assembly shall be heavy chrome plated cast brass grid strainer outlet and seamless brass tailpiece assembly, McGuire Model 155A, with 1 ¼" x 1 ½" chrome plated heavy cast brass body p-trap with cleanout plug and cast brass locknuts, 17 gauge chrome plated tubular brass wall bend and chrome plated brass deep wall flange, McGuire Model 8902DF or approved equivalents by Zurn, Keeney Manuf. Co., Dearborn Brass, Just Manuf. Co. or Kohler.

Sink: Unless otherwise specified on drawings, sink waste outlet assembly shall be stainless steel basket strainer and 1 ½" brass tailpiece assembly, Elkay LK35, with 1 ½" x 1 ½" chrome plated heavy cast brass body p-trap with cleanout plug and cast brass locknuts, 17 gauge chrome plated tubular brass wall bend and chrome plated brass deep wall flange, McGuire 8912DF. For two compartment sinks, provide chrome plated heavy duty, end outlet, continuous waste assembly with cast brass tees, 17 gauge seamless brass tubing, cast brass slip nuts and cleanout end caps, McGuire Model 520A2. Approved equivalent components by Zurn, Keeney Manuf. Co., Dearborn Brass, Just Manuf. Co. or Kohler will be acceptable.

Fixture Supports and Fastenings:

Lavatory wall hangers shall be cadmium plated cast iron. Floor and wall plates and escutcheons shall be furnished and shall be as specified hereinbefore or as included by the fixture assembly numbers. All lavatories shall be set 36” from floor to basin top for able body persons, 34” from floor to basin top for ADA-H/C requirements or as otherwise noted on the contract documents.

Fixtures and equipment wall brackets and hangers shall be supported and fastened in a satisfactory manner. Where secured to freestanding marble, slate soapstone, or glass, supports shall be fastened with ¼” brass through-bolts. Where secured to concrete or brick walls, supports shall be fastened with brass bolts or machine screws in lead sleeve type anchorage units or with brass expansion bolts. Expansion bolts shall be ¼” brass bolts with 20 threads to the inch and of sufficient length to extend at least 3” into solid concrete or brickwork, fitted with loose tubing or sleeves of proper length to bring expansion sleeves in the solid concrete or brick wall. Where secured to hollow clay tile walls or partitions, supports shall be fastened with ¼” brass toggle or through-bolts.

Inserts shall be securely anchored and the anchors shall be properly grouted with mortar. Inserts shall be installed flush with the finished wall and shall be completely concealed when the fixtures are installed. Supplies, shower heads and risers shall be securely anchored to masonry. Reinforcing plates and channels or floor to ceiling carriers shall be provided for anchoring supply piping and shower heads and risers in stud and gypsum wallboard or plaster partitions, or plaster partitions

Chair carriers shall be completely concealed in the building construction, provided with heavy foot or feet bolted to the floor, and with vertical members either in pipe space or built into the partition, and shall rigidly support fixtures from the floor or floor and ceiling structure where indicated or specified. Chair carriers shall be epoxy paint coated cast iron with adjustable and invertible face plate with adjustable legs and feet (unless otherwise specified), both vertically and horizontally and shall support fixtures in such a manner that no part of fixture will be supported by wall or partition. All parts shall be made of metal; castings shall be of strong, tough, even-grained metals; tubular members shall be square structural shape and thickness; steel parts shall be heavy gauge with accurately punched or drilled holes; all screws and bolts shall have standard threads. Carriers for standard use water closets are to be rated for 500 lb static load capacity unless otherwise indicated on the drawings.

Bolts and nuts shall be hexagon and exposed bolts, nuts, cap nuts, and screws shall be chromium plated. Exposed nuts, cap nuts and screw heads shall be provided with chromium plated brass washers.

PART 3 - EXECUTION

INSTALLATION

Examine roughing-in work of portable water and waste piping systems to verify actual locations of piping connections prior to installing fixtures. Examine floors and substrates, and conditions under which fixture work is to be accomplished. Correct any incorrect locations of piping, and other unsatisfactory conditions for installation of plumbing fixtures. Do not proceed with work until unsatisfactory conditions have been corrected.

Install plumbing fixtures level and plumb, in accordance with fixture manufacturer's written instructions, and rough-in drawings, in compliance with applicable codes and regulations, the design Drawings, and referenced standards. Water closets, lavatories, urinals, and bidets shall not be installed closer than 15" from its center to any sidewall, partition, vanity other fixture, or other obstruction, or closer than 30" center-to-center between fixtures. There shall be at least 21" clearance in front of any fixture to wall, partition, vanity, other fixture, or other obstruction.

Comply with the installation requirements of ANSI A117.1, the *North Carolina State Building Code: Building Code*, and the *Americans with Disabilities Act Architectural Guidelines* (ADAAG) with respect to plumbing fixtures for the physically handicapped.

Secure supplies behind or within wall construction to provide rigid installation during rough-in.

Install a stop valve in an accessible location in each fixture water connection.

Install drains in compliance with Section 221316.

Install chrome plated escutcheons at each wall, floor, and piping ceiling penetration in exposed finished locations and within cabinets and millwork.

Floor-mounted water closets/toilets:

Inspect fixture to ensure that waste outlet is fully glazed, inside and out. Reject any fixture that does not meet this criteria.

Ensure that floor flange is not more that 1/2" above finished floor level and is installed plumb and square with corrosion-resistant screws or bolts.

Install fixture with a tapered wax seal **without sleeve or "horn"**. Invert toilet on floor (cushion to prevent damage) and install wax ring evenly around the fixture waste discharge, with tapered end of ring facing toilet. Place fixture over floor flange, "rock" fixture into place, and tighten flange bolts. Take care to not over-tighten flange bolts and damage fixture.
Ensure that fixture is level. Use nylon or non-hydroscopic composite toilet shims as necessary.

Seal fixtures to floor using silicone sealant. Match sealant color to fixture color.

The use of an offset closet flange is prohibited.

Wall-mounted fixtures:

Utilize carriers and ensure that fixture is not supported by the building structure.

Make waste connection with neoprene seal.

Seal fixtures to wall using silicone sealant. Match sealant color to fixture color.

For countertop sink/lavatory installations: Plumbing contractor shall provide template to general contractor for cutting openings into countertop. Sink shall be installed using appropriate setting compound to provide watertight joints between countertop and sink. Plumbing contractor shall be responsible for all connections to sink and for installation of sink.

Set shower receptor and mop basins in a leveling bed of cement grout.

FIELD QUALITY CONTROL

Inspect each installed fixture for damage to finish before installation. If feasible, restore and match finish to original at site; otherwise, remove fixture and replace with new unit. Feasibility and match to be judged by A-E.

Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning units, then retest.

ADJUSTING

Adjust water pressure at drinking fountains, faucets, shower valves, and flush valves to provide proper flow and stream.

Replace washers of leaking or dripping faucets and stops.

PROTECTION

Protect installed fixtures from damage during remainder of construction period.

Do not allow use of fixtures as temporary sanitary facilities during construction unless expressly approved in writing by the Owner.

Prior to final acceptance, clean fixtures, brass, trim, etc. using manufacturer's recommended cleaning methods and materials.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 224000

SECTION 226500 –LABORATORY AIR, GAS AND VACUUM SYSTEMS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specifications sections, apply to the work of this section.

SUMMARY

This section includes the furnishing of all labor and materials necessary for complete installation and testing of laboratory compressed air and vacuum including; piping, valves, supports, labeling, identification and all related accessories.

Laboratory systems shall include compressed air and vacuum, as indicated on the drawings.

Apparatus and equipment specified herein shall conform to the requirements of Section 220510, with net capacities and general arrangement indicated on the Plans, and shall be furnished complete with all appurtenances and incidentals necessary for satisfactory operation.

QUALITY ASSURANCE

All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

NFPA 70, *National Electric Code.*

Qualify processes and operators according to ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, *Standard for Brazing Procedure and Performance Qualification.*

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not comply fully with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Contractors Qualifications: Submit verification and compliance with Contractor qualifications as required hereinbefore.

Manufacturer's Data: Submit manufacturer's technical product data and installation instructions for gas and vacuum materials and products.

Brazer Qualification: Submit documentation showing each brazer’s successful completion of a qualification test, as hereinafter specified, within the past 12 months.

PART 2 - PRODUCTS

PRESSURIZED LABORATORY GAS PIPING

All pipe shall be Type "K", ASTM B88, hard drawn seamless copper tubing.

Turns, offsets, and other changes in direction shall be made with brazed wrought copper capillary fittings complying with ANSI B16.22 or brazed fittings complying with MSS SP-73. **Cast copper alloy fittings shall not be permitted**.

Brazing Materials:

Filler metals shall bond with and be metallurgically compatible with the base metals being joined. Flux shall not be used except where specifications permitted. Brazing filler metals shall comply with ANSI/AWS A5.8. *Specification for Filler Metals for Brazing and Braze Welding*, except that filler metals having compositions not conforming to the exact ANSI/AWS A5.8 classifications shall be permitted when used according to the manufacturer's instructions. Brazing alloys shall have a melting temperature greater that 1000 deg F.

Copper-to-copper joints shall be brazed using a copper-phosphorous or copper-phosphorous-silver brazing filler metal (BCuP series) without flux.

Dissimilar metals joints, such as copper to bronze or brass, shall be brazed using an appropriate flux with silver (BAg series) brazing filler metal.

Pipe Hangers: Hangers shall be in accordance with Section 220529.

LABORATORY VACUUM PIPING

All vacuum piping sizes 1-1/2 inches and smaller shall be as specified for pressurized laboratory gas pipe. Vacuum pipe sizes 2 inches and larger shall be Type "K" hard-drawn seamless copper, ASTM B 88 water tube.

Turns, offsets, and other changes in direction shall be made with brazed wrought copper capillary fittings complying with ANSI B16.22 or brazed fittings complying with MSS SP-73. **Cast copper alloy fittings shall not be permitted**.

Brazing Materials:

Filler metals shall bond with and be metallurgically compatible with the base metals being joined. Flux shall not be used except where specifications permitted. Brazing filler metals shall comply with ANSI/AWS A5.8. *Specification for Filler Metals for Brazing and Braze Welding*, except that filler metals having compositions not conforming to the exact ANSI/AWS A5.8 classifications shall be permitted when used according to the manufacturer's instructions. Brazing alloys shall have a melting temperature greater that 1000 deg F.

Copper-to-copper joints shall be brazed using a copper-phosphorous or copper-phosphorous-silver brazing filler metal (BCuP series) without flux.

Dissimilar metals joints, such as copper to bronze or brass, shall be brazed using an appropriate flux with silver (BAg series) brazing filler metal.

Threaded joints in laboratory vacuum distribution piping shall be limited to connections to pressure/vacuum indicators, alarm devices, and source equipment. All threads shall be tapered pipe threads complying with ANSI B1.20.1, Pipe Threads, General Purpose and be made up with polytetrafluoroethylene (such as Teflon™) tape or other thread sealant recommended for oxygen service, with the sealant applied to the male threads only. Where threaded nipples are required, these shall be I.P.S. brass. Close nipples shall not be installed.

Straight-threaded connections, including unions, flared and compression-type connections, including connections to station outlets and inlets, alarm devices, and other components shall not be permitted.

Pipe Hangers: Hangers shall be in accordance with Section 220529.

LABORATORY GAS AND VACUUM VALVES

Source, Main, Riser and Service Line Shut-off Valves:

Shut-off valves shall be full port, double seal, ball-type three piece design, designed for vacuum to 29 inches Hg and working pressures up to 600 WOG with bronze/brass body, blow-out proof stem and chrome plated brass ball and be serviceable in the line. Valve body shall have Teflon (TFE) material ball seat and stem seals. Seats/seals, lubricants and valve material shall be compatible with oxygen, nitrous oxide, compressed air, carbon dioxide, nitrogen and mixtures thereof at continuous pressure up to 600 psig and up to 100 degrees Fahrenheit.

Valve shall be provided with and operated by a lever-type handle requiring only a quarter turn from a fully open position to a fully closed position.

Valve tags showing the appropriate gas services, pressure rating, etc. shall be attached to each valve.

Each shut-off valve shall be provided with locking kit.

Solenoid Valves: Valves shall be rated for at least 125 psi, normally closed type, 24 volt actuation, brass body construction, PTFE seats, stainless steel core tube, and UL listed.

PART 3 - EXECUTION

INSTALLATION

Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

General: Piping material shall be plugged, capped, or otherwise sealed until installed. Particular care shall be taken in the storage and handling of such material to maintain its clean condition. Immediately before final assembly, such material shall be visually examined internally for contamination. The installation of individual components shall be made in accordance with the instructions of the manufacturer. Such instructions shall include directions and information deemed by the manufacturer to be adequate for attaining proper installation, testing, maintenance, and operation of the gas systems. These instructions shall be left with the owner.

Brazing:

Joints to be brazed in place shall be accessible for proper preparation, assembly, heating, filler application, cooling, cleaning, and inspection.

Tube ends shall be cut square using a sharp tubing cutter to avoid deforming the tube. The cutting wheel shall be free from grease, oil, or other lubricant not suitable for oxygen service.

Surfaces to be brazed shall be mechanically cleaned using a clean, non-shedding, abrasive pades. The use of steel wool shall be prohibited due to the possible presence of oil. Mechanical cleaning shall not result in grooving of the surfaces to be joined. After mechanical cleaning, the surfaces shall be wiped using a clean, lint-free white cloth. During this cleaning, care shall be taken to avoid contamination of the “cleaned for oxygen” internal surfaces of the tube and components. Joints shall be recleaned if contaminated prior to brazing. Joints shall be brazed within 1 hour of being cleaned.

Where dissimilar metals, such as copper and bronze or brass, are being brazed, flux shall be applied sparingly to minimize contamination of the inside of the tube with flux. The flux shall be applied and worked over the surfaces to be brazed using a stiff stainless steel bristle brush to ensure adequate coverage and wetting of the surfaces with flux. Where possible, short sections of copper tube shall be brazed to the noncopper component and the interior of the subassembly shall be cleaned of flux prior to installation in the piping system. Flux-coated brazing rods shall be permitted to be used in lieu of the application of flux to the surfaces to be joined on tube 3/4 in. nominal size and smaller.
Tube ends shall be inserted fully into the socket of the fitting. Where flux is permitted, the joint shall be heated slowly until the flux has liquefied. Once this has occurred, or where flux is not used, the joint shall be

heated quickly to the brazing temperature, taking care not to overheat the joint. Techniques for heating the joint, applying the brazing filler metal, and making horizontal, vertical, and large-diameter joints shall be as stated in sections on “Applying Heat and Brazing” and “Horizontal and Vertical Joints” in the chapter on “Joining and Bending” in the CDA *Copper Tube Handbook*.

While being brazed, joints shall be continuously purged with oil-free dry nitrogen to prevent the formation of copper oxide on the inside surface of the joint. The flow of purge gas shall be maintained until the joint is cool to the touch.

A final connection to an existing pipeline shall be permitted to be made without the use of nitrogen purge. After final connection, the affected downstream portions of the pipeline shall be tested with the source gas.

Openings in the piping system shall be kept capped or plugged to avoid unnecessary loss of purge gas while brazing and to prevent debris or other contaminants from entering the system, except that during brazing, a discharge opening shall be provided on the opposite side of the joint from where the purge gas is being introduced. During brazing, the purge gas flow rate shall be maintained at a level that will not produce a positive pressure in the piping system. After brazing, the discharge opening shall be plugged or capped to prevent contamination of the inside of the tube.

Each brazed joint shall be visually examined after cleaning of the outside of the joint. The following conditions shall be considered unacceptable:

Flux or flux residue.
Excessive oxidation of the joint.
Presence of unmelted filler metal.
Failure of the filler metal to be clearly visible all the way around the joint at the interface between the socket and the tube.
Cracks in the tube or component.
Cracks in the braze filler metal.
Failure of the joint to hold test pressure.

Brazed joints found to be defective shall be permitted to be repaired, except that no joint shall be repaired more than twice. Brazed joints that are found to be defective shall be replaced. Due to excessive oxidation or cracks.

Piping shall not be installed in kitchens, electrical switchgear rooms, elevator shafts, and areas with open flames.

Shut-off valves installed for future connections shall be provided with downstream piping closed with a brazed cap and sufficient tubing allowance for cutting and re-brazing.

Branch takeoffs from horizontal piping shall be taken off above the centerline of the main or branch pipe and rise vertically or at an angle of not less than 45 degrees from vertical.
Support all piping in accordance with Section 220529 and comply with seismic requirements of Section 019923.

Pressure and vacuum indicators shall be readable from a standing position.

All zone valves and alarm panels shall be mounted at a height allowing monitoring and operation from a standing position.

Headers:

Each header shall include the following:

Safety relief valve on cylinder side of shutoff valve.

Shutoff valve, safety relief valve, filter, high side pressure gauge, regulator, low side pressure gauge, safety relief valve, and check valve, all located downstream of the last cylinder connection:.

Safety relief valve installed downstream of the header check valve.

A primary, secondary, and reserve headers shall be provided to connect to the manifold controls.

Each Header shall have a minimum of (4) four cylinder connections.

Labeling: All pipe and tubing shall be labeled in accordance with Section 220553.

TESTING AND INSPECTION

After installation of the distribution piping and before installation of station outlets/inlets and other system components (e.g., pressure/vacuum alarm devices, pressure/vacuum indicators), piping in laboratory vacuum and gas distribution systems shall be blown clear by means of oil-free, dry Nitrogen.

Provide the services of a factory technician for at least 16 hours to start and test air compressors and vacuum pumps.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 226500

SECTION 226700 - PURIFIED WATER SYSTEMS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

The requirements specified herein shall govern all Sections in Division 22, whether stated therein or not.

Where items specified in the other sections of this Division conflict with requirements of this Section, the former shall govern.

DESCRIPTION OF WORK

This section includes purified water systems as indicated on the Drawings to produce purified water at meet the following requirements:

DESCRIPTION	
Electrical conductivity, max, µS/cm	0.056
Electrical resistivity, min, MΩ-cm	18.0
pH	6.8-7.0
Total organic carbon (TOC), max, µg/L	50
Sodium, max, µg/L	1
Particles >0.22 µm/ml, max	<1.0
Maximum heterotrophic bacteria count/ml	1
Endotoxin (pyrogens) limit, Endotoxin Units (EU)/ml	0.03

Minimum Working Pressure Rating Requirements: 60 psig unless indicated otherwise.

QUALITY ASSURANCE

Comply with ASME B31.3, "Process Piping," for piping conveying fluid at a pressure of 15 psig or greater.

Comply with the following requirements for purified water, as applicable:

ASTM Standard D 1193 - 06 (2011), *Standard Specification for Reagent Water*

ASTM D 5196 - 06, *Standard Guide for Bio Application Grade Water*;
Clinical Laboratory and Standards Institute Standard C3-A4, *Preparation and Testing of Reagent Water in Clinical Laboratories*

ASTM D 5129- 99, *Ultra Pure Water Used in the Semi-Conductor and Electronics Industry*.

Unites States Pharmacopoeia (USP) Standards 23 and 24 for pharmaceutical grade pure waters.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data and installation instructions for materials and products.

PART 2 - PRODUCTS

GENERAL

Provide packaged purified water systems consisting of the following elements and distribution piping as indicated on the drawings:

Carbon filter

Mixed bed deionization (DI) units

UV oxidation sterilizer

Recirculation Pump

PIPE AND FITTINGS

Polypropylene (PP) Pipe, Fittings, and Valves:

Pipe and fittings shall be made from ASTM D 4101, PP resin.

Schedule 80: Pipe made to ASTM D 2447, Schedule 80 dimensions; with socket fittings matching pipe dimensions.

Electro-Fusion Fitting: Electrical-resistance heating coil for PP piping joints.

PP Ball Valves:

Standard: MSS SP-122.
Pressure Rating: 150 psig.
Body Material: ASTM D 4101, PP resin.
Body Design: Union type.
End Connections: Detachable, butt or socket.
Ball: ASTM D 4101, PP resin.
Port: Full.
Seats: PTFE.
Stem: ASTM D 4101, PP resin.
Stem Seals: EPDM-rubber O-rings.
Handle: Tee shaped.

PART 3 - EXECUTION

PIPING INSTALLATION

Drawing plans and details indicate general location and arrangement of water piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

All piping shall be pre-cleaned and sealed on ends at the manufacturing plant and shall remain sealed until installed.

All valves and fittings shall be pre-cleaned and packaged in sealed polyethylene bags.

Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

Install piping indicated to be exposed and in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

Install piping above accessible ceilings to allow sufficient space for removal of ceiling panel, and coordinate with other services occupying that space.

Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

Install piping to permit valve servicing.

Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure ratings unless otherwise indicated.

Install piping free of sags and bends.

Install fittings for changes in direction and branch connections.

Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements of Section 220517.

Before using, purge new piping and parts of existing piping that have been altered, extended, or repaired. Clean piping by flushing with deionized, distilled or reverse-osmosis water matching the piping service requirement.

PIPING JOINT CONSTRUCTION

Join dissimilar pipe materials with transition fittings compatible with pipe materials being joined.

VALVE INSTALLATION

Install sectional valves close to mains on each branch and riser serving equipment.

Install shutoff valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

Locate valves for easy access and provide separate support where necessary.

Install valves of same size material as the pipe or tube in which they are installed unless otherwise indicated.

Install valves in horizontal piping with stem at or above center of pipe.

Install valves in position to allow full movement of stem and lever handle.

Install ball-check valves in horizontal or vertical position so ball will unseat during normal flow.

Install swing-check valves in horizontal position with the hinge pin level.

PIPING HANGER AND SUPPORT INSTALLATION

Comply with requirements for pipe hanger and support devices and installation specified in Section 220529.

Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.

Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.

Clamps for Vertical Piping: MSS Type 8 or Type 42.

Individual, Straight, Horizontal Piping Runs:

100 Feet and Less: MSS Type 1, adjustable clevis hangers.

Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.

Multiple, Straight, Horizontal Piping Runs:

MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

Support vertical piping and tubing at base and at each floor.

Rod diameter may be reduced one size for double-rod hangers, to minimum 3/8 inch.

Install padded hangers for PP piping with the following maximum horizontal spacing and minimum rod diameters:

NPS 1 and Smaller:	32 inches with 3/8-inch rod.
NPS 1-1/4 to 2:	48 inches with 3/8-inch rod.

NPS 2-1/2 and 3:	48 inches with 1/2-inch rod.

Install padded supports for vertical PP piping NPS 2-1/2 and larger every 120 inches and mid-story for NPS 2 and smaller.

Install padded hangers for PVDF piping with the following maximum horizontal spacing and minimum rod diameters:

NPS 1 and Smaller:	30 inches with 3/8-inch rod.
NPS 1-1/4:	33 inches with 3/8-inch rod.
NPS 1-1/2 to 2:	36 inches with 3/8-inch rod.
NPS 2-1/2 and 3:	48 inches with 1/2-inch rod.

Install padded supports for vertical PVDF piping NPS 2-1/2 and larger every 120 inches and mid-story for NPS 2 and smaller.

Install hangers for stainless-steel tubing with the following maximum horizontal spacing and minimum rod diameters:

NPS 1 and 1-1/4:	72 inches with 3/8-inch rod.
NPS 1-1/2 to NPS 2:	96 inches with 3/8-inch rod.
NPS 2-1/2:	108 inches with 1/2-inch rod.
NPS 3:	120 inches with 1/2-inch rod.

Install supports for vertical stainless-steel tubing every 10 feet.

Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

PIPING CONNECTIONS

Drawings indicate general arrangement of piping, fittings, and specialties. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment. Connect piping to equipment and service outlets with unions or flanges.

PIPING IDENTIFICATION

Comply with requirements for piping and equipment identification of Section 220553.

FIELD QUALITY CONTROL

Test new piping, and parts of existing piping that have been altered, extended, or repaired, for leaks and defects. Schedule tests and their inspections with at least 24 hours' advance notice.

Do not cover piping or put into service before inspection and approval.

Hydrostatically test completed piping at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than 100 psig.

Replace leaking joints with new materials and retest until no leaks exist.

Submit separate reports for each test.

END OF SECTION 226700

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SECTION 230210 – HVAC SUMMARY OF WORK

Engineer of Record for Heating, Ventilating, and Air-Conditioning work is Chris P. Cagle, PE, Salas O'Brien North Carolina, Inc., 702 Oberlin Road, Suite 300, Raleigh, NC 27605 (919) 832-8118. Heating, Ventilating, and Air-Conditioning work shall be defined by drawings numbered with the prefix "H-", the general provisions of the Contract including General Conditions and Supplementary Conditions, Division 1 Specification sections, and Division 23 Technical Specification sections listed below. In addition, Heating, Ventilating, and Air-Conditioning work may be defined by reference to other documents by any of the above-named sources as well as by project addenda.



06/30/2025

DIVISION 23 - HVAC TECHNICAL SPECIFICATIONS

Section	Title
230210	HVAC Summary of Work
230510	HVAC Basic Requirements
230511	Electrical Provisions for HVAC Work
230513	Electrical Motors for HVAC Equipment
230514	Variable Frequency Drives for HVAC Motors
230517	Sleeves and Sleeve Seals for HVAC Piping
230521	HVAC Piping Specialties
230523	HVAC General-Duty Valves for Hydronic Piping
230529	Hangers and Supports for Piping, Ductwork & Equipment
230533	Heat Tracing for HVAC Piping
230548	HVAC Vibration Control
230553	HVAC Painting and Identification
230555	HVAC Pipe Flushing, Testing, and Cleaning
230593	HVAC Testing, Adjusting, and Balancing
230713	HVAC Duct Insulation
230716	HVAC Equipment Insulation
230719	HVAC Piping Insulation
230913	Instrumentation and Control Devices for HVAC
230923	Extend Existing Direct Digital Control System for HVAC
230993	Sequences of Operation
232113	Above Ground Hydronic Piping
232123	Hydronic Pumps
232300	Refrigerant Piping
232513	Closed Hydronic Systems Water Treatment
233100	HVAC Ductwork
233300	Air Duct Accessories
233416	Centrifugal HVAC Fans
233423	HVAC Power Ventilators
233450	Laboratory Exhaust System – Centrifugal Air Fans
233600	Air Terminal Units
233650	Laboratory Venturi Airflow Control Valves
233713	Diffusers, Registers, and Grilles

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DIVISION 23 - HVAC TECHNICAL SPECIFICATIONS

Section	Title
234113	Particulate Air Filtration, Low Efficiency (MERV 6-8)
234123	Particulate Air Filtration, Medium Efficiency (MERV 9-16)
234213	UVGI Systems
235543	Unfired Unit Heaters
237314	Custom Air-Handling Units
238116	Ductless Split System Air-Conditioning Units
238121	Packaged Air-Cooled Heating and Cooling Units
238216	Air Coils
238219	Fan Coil Units
238233	Convectors
238413	Humidifiers

END OF SECTION 230210

SECTION 230510 – HVAC BASIC REQUIREMENTS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

The requirements specified herein shall govern all Sections in Division 23, whether stated therein or not.

Where items specified in the other sections of this Division conflict with requirements of this Section, the former shall govern.

SUBMITTALS

Submittals shall be made in strict accordance with the requirements of Section 019913. Specific submittal requirements are defined in each section of this Division.

Submit Welder's and Brazer's Qualifications in accordance with Section 019913. Welders' and Brazers' Qualifications: Operators who are to do the welding and/or brazing must be properly qualified to do satisfactory work. **Proof of an operator's qualifications shall be either the Contractor's record of suitable tests passed within the preceding six months while in the employ of the Contractor, or tests made before the start of work.** Submit qualification data for each operator prior to their starting work. Any workman considered by the A-E as not having the skill necessary for the work shall be required to pass an appropriate qualification test or shall be at once barred from further welding and/or brazing on the project.

EQUIPMENT SELECTION

Pump heads and fan static pressures indicated on the Drawings are for estimating purposes and are based on the individual equipment losses as indicated. If the Contractor proposes using equipment, components, pipe or duct routing, etc. that will increase the pump heads and/or fan static pressures, any required pump or fan changes, along with associated motor and power wiring changes, shall be at the Contractor's expense.

TEMPERATURE AND HUMIDITY CRITERIA

Indoor temperature and humidity conditions in occupied spaces, unless specifically specified or indicated otherwise on the Drawings, shall be maintained as follows:

Space/ Area	Indoor Air Condition	Occupied Periods	Unoccupied Periods
General occupied spaces	Dry Bulb Temperature	70-75 deg F	55 deg F, Minimum 85 deg F, Maximum
	Relative Humidity	30-60% RH	65% RH Maximum
Conservation	Dry Bulb Temperature	68-72 deg F	-
	Relative Humidity	40-50% RH	-

ACOUSTIC CRITERIA

Noise levels due to HVAC equipment, ducts, grilles, registers, diffusers, etc., shall result in maximum sound levels in occupied spaces conforming to the following Room Criteria (RC):

Max. RC	Environment	Typical Occupancy
25	Extremely quiet environment, suppressed speech is audible, suitable for acute pickup of all sounds.	Broadcast or recording studios, concert halls, music rooms, bedrooms, special classrooms for the very young or hearing impaired, etc.
30	Very quiet, suitable for large conferences; telephone use satisfactory; sleeping unimpaired.	Residences, hotel or hospital sleeping rooms, theaters, auditoriums, libraries, executive offices, directors' rooms, large conference rooms, etc.
35	Quiet, suitable for conference at 15 ft. table; normal voice 10-30 feet; telephone use satisfactory.	Private offices, school cafeterias, court rooms, churches, small conference rooms, etc.
40	Satisfactory for conferences at 6-8 ft. table; normal voice 6-12 ft.; telephone use satisfactory	General (open) offices, school corridors, laboratories, restaurants, etc.
45	Satisfactory for conferences at 4-5 ft. table; normal voice 3-6 ft., raised voice 6-12 ft; telephone use is somewhat difficult.	Retail stores, cafeterias and fast food dining, lobbies or public areas, etc.
50	Unsatisfactory for conferences; normal voice 1-2 ft., raised voice 3-6 ft.; telephone use is difficult.	Workshops, machine rooms, industrial process areas, etc.

Outdoor HVAC equipment shall be selected, located, and oriented to limit the "Equivalent Sound Level" (LA_{eq},T) A-scale sound pressure level (dBA), averaged over T=16 hours, to 50 dBA or less at the site boundary or at a distance of 100 feet, whichever is closer to the equipment.

VIBRATION CRITERIA

Unless indicated otherwise on the Drawings for building areas, vibration transfer to the building structure in each octave band, directly or indirectly, from HVAC equipment shall be limited to comply with the following, where "curve" indicates the applicable vibration criteria curve shown in Fig. 41, Chapter 48, *2007 ASHRAE Handbook, HVAC Applications*:

Occupancy Type	Curve
Workshops, machine rooms, industrial process areas, etc.	Workshop
Retail stores, commercial cafeterias and fast food dining, lobby or public areas, general (open) offices, school corridors, restaurant and entertainment facilities, etc.	Office
Private offices, school cafeterias, court rooms, churches, conference rooms, residences, general classrooms, theaters, libraries, executive offices, directors' rooms, hospital patient care areas, etc.	Residential, Night
Hospital operating rooms and critical care areas, etc.	Operating Room
Research laboratories, etc.	VC-A, Research Laboratory
Vibration sensitive equipment or procedure areas	VC-A through VC-E, as indicated on the Drawings

PART 2 - PRODUCTS (Not Used)

PART 3 – EXECUTION

COMMISSIONING PROCESS

The Owner has retained a Commissioning Authority to develop, implement, and manage the commissioning process for this Division's systems, subsystems, assemblies, and/or components.

In addition to the requirements specified in this Division, the Contractor shall review and accept commissioning process construction checklists, prerequisites to testing, system and assembly tests, and requirements for test reports are specified by the Commissioning Authority in Division 1.

To support the commissioning process, a Commissioning Team, has been organized under the management of the Commissioning Authority. The Contractor shall assign a representative to serve as a member of the Commissioning Team to aid in the commissioning process. In addition, the Contractor shall require that each significant Subcontractor assign a representative to the Commissioning Team and participate in the commissioning process.

Contractor and Subcontractor representatives shall have the expertise and authority to act on behalf of their organizations and shall participate in and perform commissioning process activities including, but not limited to, the following:

Integrate and coordinate commissioning process activities into construction activities and schedules.

Attend and participate in Commissioning Team meetings specified in Division 1.

Complete construction checklists as work is completed and submit to Commissioning Authority.

Accomplish commissioning process test procedures and prepare test reports as specified by the Commissioning Authority.

Evaluate performance deficiencies identified in test reports and recommend corrective action.

PIPING WELDING/BRAZING/SOLDERING

High Pressure Piping (above 15 Psig):

Refrigeration piping systems shall be fabricated, assembled and welded/brazed/soldered in accordance with the ASME B31.5.

Low Pressure Piping (15 Psig or below):

Copper make-up water and drainage piping systems shall be fabricated, assembled and brazed/soldered in accordance with ASTM B828.

Other low pressure piping systems shall be fabricated, assembled and welded/brazed/soldered in accordance with the ASME B31.9.

Non-Destructive Inspection and Testing: A/E shall visually inspect pipe welds. Based on visual inspections, upon order of the A/E, non-destructive testing of selected pipe welds shall be performed by a qualified testing agency, at the expense of the Owner, using one of the following methods selected by the A/E. The welds inspected shall be selected randomly, but the selection shall include an examination of welds made by each welding operator or welder.

Radiographic testing in accordance with ASTM E 94:

Make identification of defects by comparing radiographs to reference radiographs in ASTM E 390.

Film shall positively and properly identify as to member being inspected, location of weld, and location of film on weld.
Stamp identification on steel so film may be easily identified and matched to identification mark.

Ultrasonic testing in accordance with ASTM E 164:

Size of defects will be determined by relating amplitude of oscilloscope traces to hole in ASTM reference weldment.

Diameter of reference holes shall be 3/32-inch.

Weld defects which are cause for rejection include cracks, lack of fusion, incomplete penetration, porosity, or slag inclusions which produce reflections equal to or greater than 80 percent of reference hole reflection and have linear dimensions as indicated by transducer movement exceeding 1/4-inch for material thickness up to and including 3/4-inch.

Correction of Defective Welds: If random testing reveals that **any welds** fail to meet minimum quality requirements, an additional 10 percent of the welds in that same group shall be inspected at the Contractor's expense. If all of the additional welds inspected meet the quality requirements, the entire group of welds represented shall be accepted and the defective welds shall be repaired. If any of the additional welds inspected also fail to meet the quality requirements, that entire group of welds shall be rejected. At the Contractor's option, the rejected welds shall be removed and the joints rewelded or the rejected welds shall be 100 percent tested as hereinbefore specified and all defective weld areas removed and rewelded.

ROOFTOP EQUIPMENT INSTALLATION

Safety rails or guards shall be provided when HVAC equipment that requires periodic service or maintenance is located at an elevation greater than 30" above the floor, roof, or grade below and the equipment or access path for that equipment is located within 72" of the roof edge or open side of a walking surface. Guards shall extend not less than 30" beyond each end of the equipment and the guard shall be at least 42" high. Guards shall be constructed in compliance with Section 1012 of the *North Carolina State Building Code: Building Code*.

When HVAC equipment that requires periodic service or maintenance is located at an elevation greater than 16 feet above the floor, roof, or grade below, permanent access complying with Paragraph 306.5 of *North Carolina State Building Code: Mechanical Code* shall be provided.

Where HVAC equipment that requires periodic service or maintenance is located on a roof having a slope greater than 3-in-12, a level work platform shall be provided on each side of the of the equipment to which access is required. Platforms, and access to them, shall comply with Paragraph 306.5.1 of *North Carolina State Building Code: Mechanical Code*.

OPERATION OF HVAC SYSTEMS

The use of permanent HVAC systems to support general construction activities is prohibited. The need for heating, cooling, dehumidification, and/or ventilation during construction by the General Contractor or any project sub-contractor shall be met via use of temporary HVAC units or systems, as specified in Division 01, provided by the contractor(s) having the need.

HVAC equipment, subsystems, and/or systems may be started and temporarily operated as necessary to perform the work, testing, balancing, and/or verification as specified in various sections of Division 23. Air systems shall be started **only** after general construction activities in the areas served by the air systems are such that there is low risk of contamination and/or degradation to the system. Generally, the following construction status is required within the entire area served by an individual air system:

Floor/wall/ceiling preparation that requires sanding or other dust producing work is complete.

Wall/ceiling surfaces required to be painted shall at least have one coat of primer applied.

Ceiling spray-on decorative or acoustical coatings, where specified, are complete.
Lay-in ceilings, where specified, have been installed.

Floors finishes (tile, carpet, paint, etc.) shall be complete.

Dust-producing outdoor (site) work has been completed.

During temporary operation of air systems, the following additional measures are required:

Filters shall be installed in fan coil units, air handling units, etc., as specified in Sections 234113 and 234123, as applicable.

Install temporary roll media filters (minimum MERV 13) over each air inlet (return or exhaust). Temporary filters shall be replaced regularly in order to minimize pressure losses impose on fans.

Windings of open, drip proof electric motors shall be cleaned using low pressure compressed air at the end of each 72 hours of operation.

Once HVAC systems verification/commissioning has been completed, air systems shall be shut down, temporary filters removed, and air handler filters replaced with new unless specifically directed otherwise by the A-E. **Only upon receipt of written approval by the A-E shall HVAC systems be placed into final service prior to Substantial Completion of the Project.**

END OF SECTION 230510

SECTION 230511 - ELECTRICAL PROVISIONS FOR HVAC WORK

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

The requirements specified herein shall govern all Sections in Division 23, whether stated therein or not.

Where items specified in the other sections of this Division conflict with requirements of this Section, the former shall govern.

DESCRIPTION OF WORK

Work includes, but is not necessarily limited to the following:

Provide electrical heating coils and similar elements in mechanical equipment.

Provide motor starters for furnished equipment where starters are required for the intended application when **not provided under Division 26**. Starters shall be sized in accordance with the latest edition of the National Equipment Manufacturers Association (NEMA) standard ratings for magnetic starters, and the *National Electrical Code* (NEC).

NEMA Starter Sizes for Motors					
NEMA Starter Size	Maximum HP for System Voltage (V)/ Phase (PH)				
	120V/1PH	240V/1PH	208V/3PH	240V/3PH	480V/3PH
00	1/3	1	1-1/2	1-1/2	2
0	1	2	3	3	5
1	2	3	7-1/2	7-1/2	10
2	3	7-1/2	10	15	25
3	7-1/2	15	25	30	50
4	-	-	40	50	100

Provide disconnect switches for all furnished equipment. Disconnect switches shall be sized in accordance with the latest edition of the NEC for single motor applications as follows:

Disconnect Switch Sizes for Motors						
Switch Rating Amps (A)	Maximum HP at System Voltage (V))/ Phase (PH)					
	120V/1PH	208V/1PH	240V/1PH	208V/3PH	240V/3PH	480V/3PH
30A	1-1/2	3	3	5	7-1/2	15
60A	3	7-1/2	10	15	15	30
100A	5	10	10	25	25	60
200A	-	-	-	50	60	100
400A	-	-	-	100	125	250
600A	-	-	-	150	200	400

Disconnect switches shall be sized for all other applications based on total kW rating of the equipment as follows:

Disconnect Switch Sizes for Equipment							
Switch Rating Amps (A)	Maximum kW at System Voltage (V)/ Phase (PH)						
	120V/ 1PH	208V/ 1PH	240V/ 1PH	277V/ 1PH	208V/ 3PH	240V/ 3PH	480V/ 3PH
30A	2.8	5.0	5.8	6.6	8.6	10.0	19.9
60A	5.8	10.0	11.5	13.3	17.3	19.9	39.9
100A	9.6	16.6	19.2	22.2	28.8	33.2	66.4
200A	19.2	33.3	38.4	44.3	57.6	66.4	132.9
400A	38.4	66.6	76.8	88.6	115.1	132.9	265.7
600A	57.6	99.8	115.2	133.0	172.7	199.3	398.6

Dual element fuses shall be provided with disconnect switches. Fuses shall be sized based on the nameplate rating for the equipment.

Equipment enclosures for disconnect switches, starters, variable frequency drives, control panels and any other panel enclosures housing electrical equipment shall be rated based on NEMA standard ratings. Panel enclosures shall be suitable for the environment in which they will be installed. Unless noted otherwise, provide NEMA rated enclosures based on the following environment conditions:

NEMA Enclosure Ratings for Electrical Equipment	
NEMA Type	Environment Condition
1	Indoors only, dry, low dust, and non-corrosive environment
3R	Outdoors, weatherproof and rainproof
4	Outdoors, watertight and raintight
4X	Same as 4 plus corrosion resistant
7	Hazardous locations Class I, Groups A, B, C, or D
9	Hazardous locations Class II, Groups E, F, or G
12	Indoors subject to circulating non-hazardous dust, or dripping non-corrosive liquids

Provide all single phase interlock and control wiring required for sequenced operation of mechanical devices provided for mechanical systems under Division 23. Under Divisions 26-28, a source of power for these devices shall be provided and extended to the devices under Division 23.

Make all power wiring connections for mechanical equipment as recommended by the equipment manufacturer. Under Divisions 26-28, power wiring to the line side of a disconnecting provided and installed under Division 23 will be provided.

Some items of equipment may require conductor and/or raceway combinations different from the supply conductors provided under Division 26-29 to the equipment disconnect; coordinate and provide connections as recommended by the equipment manufacturer.

Division 23 Contractor is responsible for providing and installing fuses in disconnects that supply Division 23 utilization equipment.

Provide any required power wiring not specifically shown on the electrical drawings (E-Sheets) or specified in Divisions 26-28.

Install duct smoke detectors furnished under Divisions 26-28 and incorporate smoke detectors in interlock and control wiring. Provide appropriate access doors for duct smoke detectors.

QUALITY ASSURANCE

Coordination with Electrical Work: Wherever possible, match elements of electrical provisions of mechanical work with similar elements of electrical work specified in Divisions 26-28 sections. Comply with requirements of applicable Divisions 26-28 sections for raceways and wiring methods associated with final electrical connections to equipment installed under this Division.

Standards:

For electrical equipment and products, comply with applicable NEMA standards and refer to NEMA standards for definitions of terminology herein.

Comply with NFPA 70, *National Electrical Code* (NEC) for workmanship and installation requirements.

Comply with NFPA 70E, *Standard for Electrical Safety in the Workplace*, while performing any electrical work. **(NFPA 70E is referenced in OSHA 29CFR Part 1910, Subpart S, Appendix A, and is considered by OSHA as the industry practice for electrical safety.)**

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data and installation instructions for electrical materials and products.

Source Limitations: Provide motor starters, combination motor starters, and disconnects through one source from a single manufacturer.

PART 2 - PRODUCTS

MOTOR STARTERS

Motor Starters: Provide surface-mounted, heavy duty, steel enclosed motor starters with NEMA size rating, voltage rating, and current rating based on the tables provided in Part 1 of this specification.

Motor starters are three pole types. Starters shall be rated as follows unless otherwise specified:

For 480Y/277 V.: Use 600 volt type

For 208Y/120 V.: Use 250 volt type

For 120/240 V.: Use 250 Volt type

Provide full voltage, non-reversing magnetic motor starters with auxiliary control devices as indicated.

Provide units with RMS symmetrical fault withstand rating suitable for application, but no less than 22,000 amps. Design of units shall ensure that faults will be contained within the starter enclosure.

Running Overload Protection: Equip with thermal overload protection device for each motor circuit.

Auxiliary Contacts: Provide two sets of normally open auxiliary contacts and two sets of normally closed auxiliary contacts.

Provide additional **sets** of normally open and/or normally closed auxiliary contacts is such are required to accomplish control functions as defined by the drawings or required by specified control and interlock sequence(s).

Provide additional sets of contacts as required to operate pilot lights as described elsewhere. Contacts required to operate pilot lights are **not shown on the Drawings**. Contacts required to operate pilot lights are to be furnished at no additional cost.

Accessories on Cover: Provide the following accessories on the combination starter cover.

Reset Pushbutton

Hand-Off-Automatic (HOA) Switch

Push to Start Switch

Pilot Lights on Cover: Pilot lights are to be transformer types, configured to operate from the same voltage as the motor starter coil. Provide the following pilot lights on the starter cover.

Red Pilot Light, illuminated when starter is energized

Green Pilot Light, illuminated when starter is not energized

Disconnect Auxiliary Contacts: Provide 2 pole disconnect auxiliary contacts for control circuits where control circuits are provided from a separate electrical source.

Coils: Provide starters with operating coils for 120 volts.

Control Transformer: Provide control transformer having a primary voltage rating to match the line-to-line voltage of the motor supplied by the starter and a secondary voltage to match the voltage of the starter coil. Size control transformer to supply the starter and all pilot devices supplied with a 25% reserve capacity for additional pilot devices.

Provide NEMA-rated enclosure type suitable for its environment as required by Section 230511.

COMBINATION MOTOR STARTERS

General: Combination starters may be used in lieu of separate disconnect and motor starter. Provide surface-mounted, heavy duty, steel enclosed combination motor starters meeting requirements described for motor starters. Provide combination motor starters with NEMA size rating, voltage rating, current rating, and number of poles indicated on the Drawings.

Circuit Breakers: Provide factory-assembled, molded-case circuit breakers with permanent instantaneous magnetic trips in each pole, with fault-current interrupting rating suitable for application and ampere ratings as indicated. Circuit breaker ratings must be clearly visible when the compartment door is open without the necessity of removing operating mechanisms or similar items to obtain visibility. Where adjustable circuit breakers are provided, such adjustments must be also be readily accessible once the compartment door is opened. Provide push-to-trip feature for testing and exercising circuit breaker trip mechanism. Construct breakers for mounting and operating in any physical position and in ambient temperature of 40° C. Provide with AL/CU rated screw type removable connector lugs. Field coordinate all circuit breaker sizes with equipment nameplate ratings prior to purchase.

Disconnect Operators: Provide external operator handles for circuit breakers. Design handle with up-down motion and with down position indicating “OFF." Combination Motor Starters with rotary type circuit breaker operators are not acceptable. Construct handles which permit locking handle in “ON” or “OFF” position with a hasp-type padlock.

Provide two-pole interlock switches for all disconnects that are used with utilization equipment requiring control connections provided from separate electrical sources. The interlock switch is to be configured such that when the disconnect is open the interlock switch is open.

Provide additional interlock switches, auxiliary contacts, plumbing key interlocks, or other accessories as may be described by the Drawings.

Provide NEMA-rated enclosure type suitable for its environment as required by Section 230511.

CIRCUIT AND MOTOR DISCONNECTS

Safety Switches: Provide surface-mounted, heavy duty, steel enclosed safety switches, of types, voltage rating, current rating, and number of poles indicated in this Section.

Switches with no drawing indication of number of poles are three pole types. Switches shall be fusible type, rated as follows unless otherwise specified:

For 480Y/277 V.: Use 600 Volt type, with neutral and grounding bus.

For 208Y/120 V.: Use 250 Volt type, with neutral and grounding bus.

For 120/240 V.: Use 250 Volt type, with neutral and grounding bus.

Where a neutral is not provided to the specific utilization equipment served, the neutral bus can be bonded to the enclosure and used as a grounding bus.

Provide horsepower rated switches incorporating quick-make, quick-break type switches constructed so that switch blades are visible in OFF position with door open. Equip with operating handle which is integral part of enclosure base and whose operating position is easily recognizable. Internal current carrying components shall be high-conductivity copper; switch contacts shall be silver-tungsten type. Fuse holders shall have positive pressure type reinforced fuse clips. Where non-fused disconnect switches are indicated, provide solid copper bus bars in lieu of fuses.

Provide NEMA-rated enclosure type suitable for its environment as required by Section 230511.

Provide switches that may be locked in either the “ON’ or ‘OFF’ condition with a 1/4" shackle hasp-type lock. Safety switches shall have door interlocks that prevent the door from opening when the operating handle of the switch is in the “on” position. Manual defeat mechanisms shall be provided for the interlocks.

Provide two-pole interlock switches for all disconnects that are used with utilization equipment requiring control connections provided from an alternate power source. The interlock switch is to be configured such that when the disconnect is open the interlock switch is open.

Provide additional interlock switches, auxiliary contacts, mechanical key interlocks, or other accessories as described by the Drawings.

For all outdoor equipment, provide a fused weatherproof disconnect switch, sized and fused in accordance with manufacturer's requirements.

Fuses shall be furnished by the Contractor. Fuses shall be current limiting type with a minimum AIC rating of 100,000 AMP. The contractor shall furnish Owner with one complete set of spare fuses at the completion of the project.

PART 3 - EXECUTION

GENERAL

Coordinate the exact location of all equipment disconnects to ensure that disconnects are located within sight of mechanical equipment.

Extend power wiring circuits from load side of termination points provided under Divisions 26-28 to each item of mechanical equipment requiring electrical power. All wiring shall be installed in raceway. All wiring and raceway shall be in compliance with Division 26. Utilize liquid tight flexible metallic conduit for weatherproof for outdoor locations. Provide all necessary clamps, fitting, connectors, raceways, circuit conductors, etc., for a completely operational system.

INSTALLATION OF CIRCUIT AND MOTOR DISCONNECTS

Install disconnects as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation," and in accordance with recognized industry practices.

Coordinate placement of disconnects with electrical raceway and cable work, as necessary for proper interface. Coordinate exact location of disconnects with equipment electrical connection point.

> Locate disconnects so that they are readily accessible after all project elements are installed. Location selected for disconnects must permit complete opening of the door or cover to the maximum amount permitted by the design of the switch enclosure.

Install disconnects for use with motor-driven appliances and motors within sight of the controllers, as indicated on the Drawings. In addition, each motor shall be provided with an approved disconnecting device within sight of the respective equipment as required by the NEC even though not specifically indicated on the Drawings. Disconnects installed for use with controllers may serve as the disconnecting means for the motor if it is in sight from the motor location and the driven machinery location.

INSTALLATION OF STARTERS

Install starters as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation," and in accordance with recognized industry practices.

Coordinate placement of starters with electrical raceway and cable work, as necessary for proper interface. Coordinate exact location of starters with equipment electrical connection point.

> Locate starters so that they are readily accessible after all project elements are installed. Location selected for starters must permit complete opening of the door or cover to the maximum amount permitted by the design of the switch enclosure.

GROUNDING

Provide equipment grounding connections, sufficiently tight to assure a permanent and effective ground, for electrical combination motor starters. All combination starters shall be grounded by means of a separate insulated grounding conductor, run with the ungrounded conductors, and bonded to the starter enclosure by means of a dedicated grounding screw terminal or bus.

FIELD QUALITY CONTROL

Subsequent to completion of installation of disconnects and motor starters, energize circuitry and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at project site, then retest to demonstrate compliance; otherwise remove and replace with new units and retest.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 230511

SECTION 230513 - ELECTRICAL MOTORS FOR HVAC EQUIPMENT

PART 1 – GENERAL

RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to the work of this Section.

The requirements specified herein shall govern all Sections in Division 23, whether stated therein or not.

Where items specified in the other sections of this Division conflict with requirements of this Section, the former shall govern.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data and installation instructions for products specified in this Section.

PART 2 - PRODUCTS

MOTOR CHARACTERISTICS

Motors shall be rated for continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

Capacity and torque characteristics shall be sufficient for motor to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or service factor.

Unless otherwise noted in the documents, Motors 1 hp and above shall be polyphase, suitable for electrical service indicated on the Drawings. Fractional horsepower motors shall be single phase, rated for operation at 120 V.

All motors shall meet the NEMA Premium™ Efficiency Standards.

All electric motor efficiencies shall comply with energy efficiency requirements of Code of Federal Regulations Title 10, Chapter II, Part 431, Subpar B “Electric Motors”.

SINGLE PHASE MOTORS

Constant speed motors larger than 1/20 hp and less than 1 hp shall be one of the following, to suit starting torque and requirements specified above:

- Permanent-split capacitor.
- Split phase.
- Capacitor start, inductor run.
- Capacitor start, capacitor run.

Constant speed motors 1/20 hp and smaller shall be shaded-pole type.

Two-speed motors shall be variable-torque, permanent-split-capacitor type.

Variable speed motors shall be electronic commutation motors (ECM), brushless DC motors with internal circuitry to convert AC power supplied to DC power to operate the motor. Motor shall be speed-controllable via internal circuitry down to 20% of full speed (i.e., 80% turndown) via 0-10 VDC or 4-20 mADC controller output signal from the building direct digital control system. Motor shall be a minimum of 85% efficient at all speeds.

Bearings shall be prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

POLYPHASE MOTORS

Polyphase motors, unless indicated otherwise, shall be in accordance with NEMA MG 1, Design B, medium induction open dripproof (ODP) type, 1.15 service factor, Class F insulation, rated as "Premium" efficiency motors by NEMA.

Motors installed on State of North Carolina projects shall comply with the requirements of Senate Bills 668 and 1946, as applicable.

Multispeed motors with 2:1 speed ratio shall be consequent pole, single winding type. Multispeed motors with other than 2:1 speed ratio shall have separate winding for each speed. Rotor shall be random-wound, squirrel cage type.

Motors located outdoors shall comply with the following:

Motor shall be TEFC, Cast Iron Construction Only (aluminum construction is prohibited) complying with the requirements of IEEE-45 *Recommended Practice for Electric Installations on Shipboard* and be classified as a “Marine Motor.” Motor construction shall include a shaft slinger on the opposite pulley end and frame surface under conduit box base shall be flat to ensure full gasket fit and prevent water entry. Nameplate shall clearly state "Marine Motor."

Motor shall be equipped with cartridge or strip heaters placed within the motor that are energized during non-operating periods to maintain the temperature inside the motor 5-10^{o}F warmer than the ambient air. Power heaters from line side of motor starter and Interlock heaters through a normally closed auxiliary contractor of the motor starter so that they are energized when the motor is not running and de-energized when the motor is running.

Motor bearings shall be regreasable, shielded, antifriction ball bearings suitable for radial and thrust loadings.

Motor frames shall be cast iron for motors 10 hp and larger; rolled steel for motors smaller than 10 hp.

For motors with reduced-voltage and multispeed controllers, match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

Motors used with variable frequency drives shall comply with the following additional requirement(s):

Motor windings shall be copper magnet wire with moisture-resistant insulation varnish and be designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulation inverters. Motors shall comply with NEMA MG 1, Part 31, to provide windings capable of withstanding up to 1600 peak volts with a rise time of 0.1 µs.

For motors provide shaft grounding rings to bleed current from the motor shaft to the motor casing.

PART 3 - EXECUTION

GENERAL

Install motors on motor mounting systems in accordance with motor manufacturer's instructions, securely anchored to resist torque, drive thrusts, and other external forces inherent in mechanical work. Secure sheaves and other drive units to motor shafts with keys and Allen set screws, except motors of 1/3 HP and less may be secured with Allen set screws on flat surface of shaft. Unless otherwise indicated, set motor shafts parallel with machine shafts.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 230513

SECTION 230514 – VARIABLE FREQUENCY DRIVES FOR HVAC MOTORS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

SUMMARY

This Section includes solid-state, pulse width modulation (PWM) type variable frequency drives (VFDs) for speed control of polyphase motors as specified in Section 230513. **The requirements of this section do not apply to VFDs furnished with hermetic or semi-hermetic refrigeration equipment.**

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Product Data: For each type of VFD, provide dimensions; mounting arrangements; location for conduit entries; shipping and operating weights; and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.

Shop Drawings: Include dimensioned plans, elevations, sections, and details, including required clearances and service space around each VFD. Provide tabulation of equipment features and ratings, as follows:

Nameplate legends.

Short-circuit current ratings of integrated unit.

UL listing for series rating of overcurrent protective devices in combination controllers.

Features, characteristics, ratings, and factory settings.

Wiring Diagrams: Provide schematic wiring diagrams for power, signal, and control wiring for each VFD.

Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

Harmonic Mitigation: Provide manufacturer documentation to define VFD harmonic mitigation components, in terms of type and impedance values. Provide total harmonic distortion levels for voltage and current, predicted at the line side of each VFD.

QUALITY ASSURANCE

Manufacturer Qualifications: Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.

Source Limitations: Obtain VFDs of a single type through one source from a single manufacturer.

Comply with NEMA ICS 7.0, *Adjustable Speed Drive Systems*.

Comply with *National Electrical Code* Section 430.120, "Adjustable-Speed Drive Systems."

STORAGE AND HANDLING

Store VFDs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFDs from exposure to dirt, fumes, water, corrosive substances, and physical damage. If stored in areas subject to weather, cover VFDs to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside drives; install electric heating of sufficient wattage to prevent condensation.

EXTRA MATERIALS

Furnish spare fuses that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Furnish one spare for every five installed, but not less than one set of three of each type and rating.

PART 2 - PRODUCTS

VARIABLE FREQUENCY DRIVES

General: VFDs shall be integrated gate bipolar transistor (IGBT) PWM type in accordance with NEMA ICS 2; listed and labeled as a complete unit and arranged to provide variable speed of a inverter duty induction motor specified in Section 230513 by adjusting output voltage and frequency.

Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

Output Rating: 3-phase; 6 to 66 Hz, with torque constant as speed changes.

VFD Requirements:

Input AC voltage tolerance: 460V, plus or minus 10 percent.

Input frequency tolerance: 60 Hz, plus or minus 2 Hz.

Ambient Temperature: 0 to 40°C.

Ambient Humidity: Up to 90 percent relative humidity (non-condensing).

Altitude: Up to 3300 feet.

Minimum Efficiency: 96 percent at 60 Hz, full load.

Harmonics Mitigation: Provide minimum 5% impedance line side reactors on all drives to minimize power line harmonics. Provide additional internal DC link reactors where line reactors fail to mitigate harmonics to levels required in this Section. Harmonic solutions shall be designed to withstand up to 2% line imbalances with the maximum current distortion not to exceed 11% at 100% load. Voltage distortion shall not exceed 5% across the load range.

Physical and electrical separation of power wiring and control wiring.

User Adjustability Capabilities:

Minimum Speed: 5 to 25 percent of maximum rpm.

Maximum Speed: 80 to 100 percent of maximum rpm.

Acceleration: 2 to a maximum of 22 seconds.

Deceleration: 2 to a maximum of 22 seconds.

Current Limit: 50 to a maximum of 110 percent of maximum rating.

Self-Protection and Reliability Features:

Short circuit interrupt capability ≥10,000 amps.

Ground fault protection.

Input transient protection by means of surge suppressors.

Snubber networks to protect against malfunction due to system voltage transients.

Under- and over-voltage trips.

Instantaneous line-to-line and line-to-ground overcurrent trips.

Phase Protection: Loss-of-phase, reverse-phase, and phase imbalance

Inverter over-temperature, overload, and over-current trips.

Motor Overload Relay: Adjustable and capable of NEMA 250, Class 20 performance. Include notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.

Motor over-temperature fault protection.

Automatic Reset and Restart: VFD shall attempt three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction.

Power-Interruption Protection: VFD shall prevent motor from re-energizing after a power interruption until motor has stopped.

Torque Boost: VFD shall automatically vary starting and continuous torque as required to insure high-starting torque and increased torque at slow speeds.

Motor at Slow Speeds:

Temperature Compensation: VFD shall automatically adjust current fall-back based on output frequency for temperature protection of self-cooled fan-ventilated motors at slow speeds.

Power Factor: VFD shall automatically boost power factor at lower speeds. Provide full-wave diode bridge rectifier to maintain displacement power factor at near unity regardless of speed or load.

Automated Energy Optimization: Provide programmable automatic energy optimization to minimized energy consumption in variable torque applications. Optimization shall dynamically adjust output voltage in response to load, independent of speed, no on frequency alone.

Automatic Motor Adaptation: Provide VFD logic to measure motor stator resistance and reactance to optimize performance and efficiency. The parameters for motor stator resistance and reactance shall be user-programmable. It shall not be necessary to spin the motor shaft or decouple the motor from the load to accomplish this optimization.

Manual Bypass: Provide manual bypass where indicated on plans. Arrange magnetic contactor to safely transfer motor between controller output and bypass controller circuit when motor is at zero speed. Controller-off-bypass selector switch sets mode, and indicator lights give indication of mode selected. Unit shall be capable of stable operation (starting, stopping, and running), with motor completely disconnected from controller (no load).

Isolating Switch: Non-load-break switch arranged to service/isolate VFD and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.

Integral Disconnecting Means: Provide factory-assembled, molded-case circuit breakers with permanent instantaneous magnetic trips in each pole, with fault-current interrupting rating suitable for application and ampere ratings as indicated. Provide external operator handles for circuit breakers. Circuit breaker ratings must be clearly visible when the compartment door is open without the necessity of removing operating mechanisms or similar items to obtain visibility. Where adjustable circuit breakers are provided, such adjustments must be also be readily accessible once the compartment door is opened. Provide push-to-trip feature for testing and exercising circuit breaker trip mechanism. Construct breakers for mounting and operating in any physical position and in ambient temperature of 40° C. Provide with AL/CU rated screw type removable connector lugs. Field coordinate all circuit breaker sizes with equipment nameplate ratings prior to purchase.

Unit Controls: **Manufacturer-furnished, factory-installed unit controls, including final control elements, shall meet the requirements of the control I/O points and sequences of operation shown on the Drawings. Unit controllers shall interface seamlessly with the BACnet direct digital control (DDC) system specified in Sections 230913 and 230923, fully complying with the operational requirements for "Control Units" specified in Section 230923.**

Panel-Mounted Operator Station: Provide operator panel mounted flush in controller door and connected to indicate the following controller parameters:

Input voltage (V) and frequency (Hz)

Output voltage (V) and frequency (Hz).

Motor speed (rpm), status (running, stop, fault), current (amperes), torque (percent of full load), and power (kW).

Fault or alarm status.

DC-link voltage (VDC).

Heat sink temperature (°F)

Digital and analog input status/value.

Digital and analog output status/value.

Elapsed motor run time.

Coordination: The Contractor shall be responsible for coordination between the controls system sub-contractor and the unit controller manufacturer/vendor to ensure that required control interface is implemented, resulting in full interoperability between unit controls and the DDC system. Provide motor feedbacks, alarms, status, etc. through BAS interface.

ENCLOSURES

Provide NEMA 1 enclosure for general duty indoor use. Provide NEMA 3R enclosure for outdoor use unless otherwise indicated. Enclosures for other locations shall be in accordance with requirements of Section 230511. Enclosures shall hinged, lockable doors and with the following:

Provisions to padlock main disconnect handle in the "Off" positions shall be provided.

Mechanical interlock to prevent opening cabinet door with disconnect in the “On” position or moving disconnect to the “On” position while the door is open.

Configure enclosure for bottom entry of incoming line power cables.

BRANCH CIRCUIT CONDUCTORS

Provide armored cable assembly for branch circuit conductors between variable frequency drive and motor load. Cable shall be 3-phase with three equipment grounding conductors and copper tape spiral shield in a galvanized interlock cable assembly. The cable connectors shall be listed for this use. Limit conductors to 50 feet or less.

PART 3 - EXECUTION

INSTALLATION

Anchor each VFD assembly to steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with VFD mounting surface.

Comply with vibration mounting requirements of Section 230548 and seismic requirements of Section 019923.

Install controller fuses in each fusible switch. Comply with requirements in Section 230511.

FIELD QUALITY CONTROL

Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including pretesting, startup service, and adjusting VFDs.

VFD Setup: Provide a "quick setup" menu with factory preset operating parameters based on motor rating and application.

Prepare for acceptance tests as follows:

Test insulation resistance for each VFD element, bus, component, connecting supply, feeder, and control circuit.

Test continuity of each circuit.

Testing: Perform the following field quality-control testing:

Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.5, 7.6, and 7.16. Certify compliance with test parameters.

Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

Test Reports: Prepare a written report to record the following:

Test procedures used.

Test results that comply with requirements.

Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

Document any controller parameters that are changed for factory default settings.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 230514

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data, including installation instructions for each type of sleeve and sleeve seal product. Submit expansion compensation schedule showing Manufacturer's figure number, size, location, and features for each required expansion compensation product.

PART 2 - PRODUCTS

SLEEVES

Cast-Iron Pipe: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

Black Steel Pipe: ASTM A 53, Schedule 40, with plain ends and welded steel collar.

Galvanized Sheet Metal: Factory-fabricated of G90 galvanized sheet metal with lock-type longitudinal seam, minimum 18 ga.

SLEEVE-SEAL SYSTEMS

Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

Pressure Plates: Stainless steel.

Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

GROUT

Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

Characteristics: Nonshrink; recommended for interior and exterior applications.

Design Mix: 5000-psi, 28-day compressive strength.

Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

SLEEVE AND SLEEVE-SEAL APPLICATIONS

Use sleeves and sleeve seals for the following piping-penetration applications:

Penetration Application	Sleeve Type	Sleeve Seal Required
Exterior walls above grade	Cast Iron	Yes
Exterior walls below grade	Cast Iron	Yes
Concrete slab on grade	Cast Iron	Yes
Concrete slab above grade	Black Steel Pipe	No
Interior partitions, fire-rated	Black Steel Pipe	No
Interior partitions, non-fire-rated	Black Steel Pipe or Galvanized Sheet Metal Sleeve	No

SLEEVE INSTALLATION

Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

Sleeves are not required for core-drilled holes. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

Cut sleeves to length for mounting flush with both surfaces.

> Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

Install sleeves for pipes passing through interior partitions. Cut sleeves to length for mounting flush with both surfaces and install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.

For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 019913.

SLEEVE-SEAL-SYSTEM INSTALLATION

Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

SLEEVE-SEAL-FITTING INSTALLATION

Install sleeve-seal fittings in new walls and slabs as they are constructed.

Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

Secure nailing flanges to concrete forms.

Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 230517

SECTION 230521 – HVAC PIPING SPECIALTIES

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data, including installation instructions, and dimensioned drawings for each type of manufactured piping specialty.

PART 2 - PRODUCTS

PIPE ESCUTCHEONS AND FLOOR PLATES

Escutcheons: Provide pipe escutcheons with polished chrome finish as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any.

Pipe Escutcheons for Moist Areas: For waterproof floors and in areas where water and condensation can be expected to accumulate, provide brass escutcheons, one piece type with setscrew or split casting type with concealed hinge and setscrew.

Pipe Escutcheons for Dry Areas: Provide stamped steel escutcheons, one piece type with spring clip fasteners or split, hinged type with spring clip fasteners.

Floor Plates: Provide floor plates as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Floor plates shall be one-piece type for new piping and split-casing type for existing piping.

DIELECTRIC FITTINGS

Dielectric Unions: Steel female pipe thread and copper solder joint ends conforming to dimensional, strength, and pressure requirements of ASME B 16.39, Class 1. Steel parts shall be galvanized or plated. Union shall have a water-impervious insulation barrier capable of limiting galvanic current to one percent of the short-circuit current in a corresponding bimetallic joint. When dry, it shall also be able to withstand a 600-volt breakdown test.

Dielectric Flanges: Factory-fabricated companion-flange assembly rated for 150 psig or 300-psig as required by system operating pressure. Include flanges, full-face or ring-type neoprene or phenolic gasket, phenolic or polyethylene bold sleeves, phenolic washers, and steel bolts, backing washers, and nuts.

THERMOMETERS

General: Provide metal case, industrial style, liquid-in-glass type thermometers of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.
Case: Die cast aluminum finished in baked epoxy enamel, glass front, spring secured, 9" long.

Adjustable Joint: Die cast aluminum, finished to match case, 180 deg. adjustment in vertical plane, 360 deg. adjustment in horizontal plane, with locking device.

Tube and Capillary: Glass tube with red organic liquid and magnifying lens, 1.5% scale range accuracy, shock mounted.

Scale: Satin faced, non-reflective aluminum, permanently etched markings.

Stem: Copper-plated steel, or brass, for separable socket, length to suit installation.

Range: Conform to the following:

Hot Water: 30 - 240 deg. F with 2 deg. F scale divisions.

Chilled Water: 0 – 100 deg. F with 2 deg. F scale divisions.

Wells: Provide thermometer wells constructed of brass or stainless steel, pressure rated to match piping system design pressure. Provide extension for insulated piping to match insulation thickness. Provide cap nut with chain fastened permanently to thermometer well.

PRESSURE GAUGES

General: Provide direct-mounted, metal case, dial type pressure gauges of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.

Type: ANSI B40.100, Grade A, 1.5% accuracy, with phosphor bronze bourdon type, bottom connection.

Case: Drawn steel or brass, glass lens, 4-1/2" diameter, liquid filled.

Connector: Brass with 1/4" male NPT. Provide protective siphon when used for steam service.

Scale: White coated aluminum, with permanently etched markings.

Range: Conform to the following:

Water: 0 - 100 psi.

PRESSURE GAUGE ASSEMBLY

General: Provide ball valve between pressure gauges and gauge tees on piping systems.

Snubber: 1/4" brass bushing with corrosion resistant porous metal disc, through which pressure fluid is filtered. Select disc material for fluid served and pressure rating.

INSERTION TEST PLUGS ("Pete's Plugs")

Provide insertion test plugs pressure rated for 500 psi and 200 deg. F as indicated on the drawings. Construct of brass and finish in nickel-plate equip with 1/2" NPS fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8" O.D. probe assembly from dial type insertion pressure gauge or thermometer. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.

FLEXIBLE PIPING CONNECTORS

Flexible connectors shall be designed for no less than 125 psi pressure and have a maximum operating temperature of 250 deg F. Each unit shall be of the proper length to accept the movement involved.

Connectors shall be neoprene-based of single- or double-sphere molded joint configuration and shall meet or exceed specifications of the Rubber Expansion Joint Division, Fluid Sealing Association.

Connectors shall be fabricated of molded EPDM, reinforced with nylon tire cord and shall have steel floating flanges or female union ends, as required to match adjacent piping.

PART 3 - EXECUTION

INSTALLATION OF PIPING SPECIALTIES

Pipe Escutcheons and Floor Plates:

Install pipe escutcheons on each pipe penetration through floors, walls, partitions, and ceilings where penetration is exposed to view, and on exterior of building. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole, and is flush with adjoining surface.

Install floor plates on each pipe penetration through floors in unfinished areas, service and equipment areas, etc.

Dielectric Unions: Install at each piping joint between ferrous and non-ferrous piping. Comply with manufacturer's installation instructions.

Flexible Piping Connectors: Install flexible connectors in piping connected to equipment mounted on vibration isolators to allow for movement between pipe and equipment. Locate flexible connector, where ever possible, in vertical piping, as close as possible to an anchor point. **Ensure that no piping load is supported by the connector**. Piping on either end of connector shall be aligned within 1/8 inch. Do not install flexible connector until all nearby welding is completed.

INSTALLATION OF TEMPERATURE GAUGES

General: Install temperature gauges in vertical upright position, and tilted so as to be easily read by observer standing on floor.

Thermometer Wells: Install in piping tee where indicated, in vertical upright position. Fill well with oil or graphite, secure cap.

INSTALLATION OF PRESSURE GAUGES

General: Install pressure gauges in piping tee with ball valve, located on pipe at most readable position. Install in piping tee with snubber or pulse pulsation dampener for water pressure gauges.

Pressure Gauge Connector Plugs: Install in piping tee where indicated, located on pipe at most readable position. Secure cap.

ADJUSTING AND CLEANING

Adjusting: Adjust faces of meters and gauges to proper angle for best visibility.

Cleaning: Clean windows of meters and gauges and factory-finished surfaces. Replace cracked or broken windows, repair any scratched or marred surfaces with manufacturer's touch-up paint.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 230521

SECTION 230523 – HVAC GENERAL-DUTY VALVES FOR HYDRONIC PIPING

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Valve Identification: Provide valves with manufacturer's name (or trademark) and pressure rating clearly marked on valve body.

ANSI/MSS Compliance: Valves shall comply with Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (ANSI/MSS) standards as referenced hereinafter. Mark valves in accordance with MSS 25.

ASME Compliance:

ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

ASME B31.9 for building services piping valves.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data, including installation instructions for each type of valve.

PART 2 - PRODUCTS

GENERAL

Valve Types: Provide valves of same type, provided by same manufacturer throughout.

Sizes: Unless otherwise indicated on the Drawings, provide valves of same size as upstream pipe size.

Operators: Provide handwheels, fastened to valve stem, for valves other than quarter-turn. Provide lever handle for quarter-turn valves 6" and smaller, other than plug valves. Where quarter turn valves are used for balancing purposes, provide memory stops. Where valves 6" and larger are located more than 8 feet AFF, provide chain operators.

HVAC WATER SYSTEMS VALVES

General: Water systems valves shall be rated at not less than 125 psig WOG at 240-deg. F.

Valves 2" NPS and smaller: Provide with screw or solder ends to match piping.

Ball Valves: Valves shall be rated 600 psi non-shock CWP and will have 2-piece cast bronze bodies, TFE seats, full port, separate packnut with adjustable stem packing, anti-blowout stems and chrome-plated brass/bronze ball, and be manufactured to comply with MSS SP110.

Globe/Angle Valves: Valves shall be Class 125 and manufactured in accordance with MSS SP80; body and bonnet are to be of bronze ASTM B62. Stems shall be of dezincification-resistant silicon bronze ASTM B371 or low-zinc alloy B99, non-asbestos packing, TFE seat disc and malleable or ductile iron handwheel.

Check Valves: Valves shall be Y-pattern swing-type manufactured in accordance with MSS SP80, Class 125, bronze ASTM B-62 body with TFE seat disc.

Valves 2 1/2" NPS and Larger: Provide with flanged ends complying with Class 150 ANSI B16.5. Working Pressure and temperature shall comply with ANSI B16.34.

Butterfly Valves: Valves shall be full lug style for use with Class 125/150 flanges, manufactured in accordance with MSS SP67 rated at least 150 psi non-shock CWP. Body to be cast iron or ductile iron. Valves to have aluminum bronze alloy or stainless steel disc with EPDM rubber seat and seals or EPDM rubber encapsulated disc with polymer-coated body. Stem shall be 400 series stainless and shall not have exposed stem-to-disc fasteners.

Globe/Angle Valves: Valves to be Class 125 manufactured in accordance with MSS SP70 (gate) or MSS SP85 (globe/angle), flanged, bolted bonnet, OS&Y, iron body, bronze trimmed, with body and bonnet conforming to ASTM A126 Class B cast iron. Packing and gaskets shall be non-asbestos.

Swing Check Valves: Swing-type check valves shall be manufactured in accordance with MSS SP71, Class 125, flanged ASTM A126 Class B cast iron body with bronze trim, non-asbestos gasket.

Spring Check Valves: Spring-type check valves shall be Class 125 with cast iron of semi-steel body in accordance with ASTM A126 Class B or A48 for use with Class 125/150 flanges, wafer type with bronze trim, bronze or EPDM seat, stainless steel spring, and stainless steel stem.

Automatic Balancing Valves: Valves shall maintain constant flow, plus or minus 5 percent, over the full range of system pressure fluctuations. Provide ASTM B584 brass body with screwed ends rated for CWP of 300 psig and maximum operating temperature of 250 deg F. Internal flow control mechanism shall consist of one-piece cartridge with segmented port design and full travel linear coil spring. Cartridge and spring shall be stainless steel, tamper proof, self cleaning, and removable. Select valve to match adjacent pipe size, 3/4"-3" NPS. Select each valve for specific flow capacity indicated on the Drawings and tag the valve with a permanent marker identifying the service, AHU or coil number, valve number, and flow rate. Replace cartridges, up to 10% of total quantity of valves, without charge due to capacity changes.

PART 3 - EXECUTION

VALVE APPLICATION

Shut-off and isolation valves 2" and smaller shall be ball valves. Shut-off and isolation valves 2-1/2" and larger shall be butterfly valves. Globe valves shall be used only where flow balancing or control is required or as indicated on the Drawings.

Drain valves shall be 3/4" ball valves with a threaded hose adaptor and cap with chain.

Blowdown valves from Y-strainers shall be ball valves, full size of blowdown connection.

VALVE INSTALLATION

Except as otherwise indicated, comply with the following requirements:

Install valves where required for proper operation of piping and equipment, **including valves in branch lines to isolate sections of piping**. Locate valves so as to be accessible and so that separate support can be provided when necessary.

Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane.

Where piping is operating at or below 70°F temperature, valves shall be equipped with stem extensions. Provide a protective sleeve for stem extensions that allows operation of the valve without breaking the vapor seal or disturbing the insulation.

Where mechanical actuators with chain operators where indicated on the drawings or specified, extend chains to 5' above floor and hook to clips to clear aisle or passage.

Installation of Check Valves:

Swing check valves shall be installed in horizontal position, oriented with the direction of flow, with hinge pin horizontally perpendicular to center line of pipe or vertically with upward flow direction.

Wafer check valves shall be installed on each pump discharge between two flanges in a horizontal or vertical position, oriented for proper direction of flow.

Install automatic flow control valves at water coils as indicated on the Drawings.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 230523

SECTION 230529 – HANGERS AND SUPPORTS FOR PIPING, DUCTWORK AND EQUIPMENT

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry, Inc. Standard Compliance: Comply with MSS SP-58 *Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation* for pipe hangers and supports.

SMACNA Compliance: Fabricate and install ductwork hangers and supports in accordance with *HVAC Duct Construction Standards - Metal and Flexible*.

ASTM Compliance: Structural steel elements utilized for piping, ductwork, or equipment support shall comply with ASTM A 36.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data, including installation instructions for each type of support and anchor.

PART 2 - PRODUCTS

GENERAL

Hangers and supports for HVAC piping, ductwork, and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

Design supports for multiple pipes and/or ducts, including floor stands, to be capable of supporting combined weight of supported systems and system contents.

Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

Structural support elements shall be fabricated from standard structural shapes complying with ASTM A 36 and/or from preformed channel struts.

Preformed channel struts shall be 1-5/8 inches wide by height required to meet load capacities and designs indicated on the drawings. Strut shall be made from steel meeting the minimum mechanical properties of ASTM A653 SS, Grade 33, G90 galvanized. Fittings shall be manufactured from steel meeting the minimum requirements of ASTM A907 SS, Grade 33. All fittings and hardware shall be zinc plated in accordance with ASTM B633, SC3 for fittings and SC1 for threaded hardware. Channel members shall be "Unistrut", Allied Support Systems "Power Strut", or Cooper B-Line Systems, Inc. "Strut System", specifically sized in accordance with the criteria hereinbefore specified.

Building attachments for hangers and supports shall be as indicated on the Drawings. Where attachments are not

indicated, they shall be as follows:

Attachment To	Attachment Method(s)
Concrete	Bolt to channel-type concrete inserts or utilize expansion anchors. Size concrete housekeeping pads so expansion anchors will be a minimum of 10 bolt diameters from the edge of the concrete base. Drill at locations and to depths that avoid reinforcing bars.
Solid Concrete Masonry Unit Walls	Use expansion anchors.
Hollow Walls	Bolt to slotted steel channels fastened to wall with expansion anchors.
Wood Structural Members	Install bolts through members.
Steel	Bolt hangers to MSS Type 19, 21, or 23 clamps on flanges of beams or on upper truss chords of bar joists. **To avoid stressing building steel structural elements, provide additional steel support members that span at least two beams or bar joists as required or as shown on the Drawings.** Attach additional steel support members via welding in accordance with AWS standards.

PIPE HANGERS AND SUPPORTS

General: Piping systems shall be classified in accordance with MSS SP-58, as follows:

Classification	Temperature Range (deg F)	Typical Service Applications
Type 1: Hot Systems	Type 1A: 120-250	Hot Water
Type 3: Cold Systems	Type 3A: 32-70	Chilled Water, Cooling Condensate Drains,
	Type 3B: <32	Liquid And Cold Gas Refrigerant

Horizontal Pipe Hangers: Except as otherwise indicated, provide factory-fabricated horizontal-piping hangers complying with MSS SP-58, of the following MSS types listed, to suit horizontal-piping systems:

For exterior and wet/damp locations, hangers and rods are to be hot dipped galvanized.

Adjustable Steel Clevis Hangers: MSS Type 1 for Classification Types 1A and 3 piping.

Split Ring Hanger: MSS Type 69 for Classification Types 1A piping, 2" NPS and smaller.

Adjustable Pipe Roller Hangers: MSS Type 43 for Classification Type 1B piping.

Copper Pipe Hangers: Copper-plated or -coated steel.
Insulation Protection: Provide MSS Type 40 insulation shield for Classification Types 1 and 3 piping at each pipe support.

Trapeze Pipe Hangers: Trapeze hangers shall be field-fabricated from structural steel members or from preformed channel members and suspended by all-thread hanger rods; weld steel, as required, in accordance with AWS standards. Each pipe on a trapeze hanger shall be individually supported as follows:

Adjustable Pipe Saddle: MSS Type 36 with adjustable support Classification Types 1A and 3 piping.

Copper Pipe Saddle: Copper-plated or -coated steel.

Insulation Protection: Provide MSS Type 40 insulation shield for Classification Types 1A and 3 piping at each pipe support.

Rooftop Pipe Supports: Provide roof pipe rails of G235 galvanized steel construction, 14 gauge, in compliance with ASTM A-446, 525, 526 and 527, with welded corners and 3" raised cant fully mitered with seams joined by continuous welds. Supports shall be internally reinforced with bulkheads and spreaders 24" on center, have factory installed 2 x 4 or 2 x 6 wood nailer and 18 ga. counterflashing. Height to be 12" above roof deck or as detailed on the Drawings. Support shall be level at the top with pitch built-in when deck slopes 1/4 of an inch per foot or greater. Each pipe on a rooftop pipe rail shall be individually supported as follows:

Adjustable Pipe Saddle: MSS Type 36 with adjustable support Classification Types 1A, 2, and 3 piping.

Adjustable Pipe Roller: MSS Type 41 with adjustable supports for Classification Type 1B piping.

Copper Pipe Saddle: Copper-plated or -coated steel.

Insulation Protection: Provide MSS Type 39 pipe saddle for Classification Type 1B piping and MSS Type 40 insulation shield for Classification Types 1A, 2, and 3 piping at each pipe support.

Exception: Uninsulated piping, 2-1/2" NPS and smaller, may be supported using manufactured, weather-resistant bearing blocks with preformed channel strut load-bearing surface and matching pipe clamps, placed directly on the roof membrane. Supports shall be Cooper B-Line Systems, Inc. "Dura-Blok", Miro Industries, Inc. supports, or equivalent.

Vertical Piping: Provide factory-fabricated riser clamps complying with MSS Type 8 to support vertical piping systems. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide copper-plated clamps for copper-piping systems.

Pipe Stands: Where indicated on the drawing, support piping with shop- or filed-fabricated assemblies made Sch. 40 black steel pipe and corrosion-resistant components. Stands shall consist of floor plate with anchors, vertical column, and pipe or equipment support element for the required application.

Outdoors: Hangers and struts located outdoors shall be hot dip galvanized after fabrication in accordance with ASTM A123. All hanger hardware shall be hot dip galvanized or stainless steel. Zinc plated hardware is not acceptable for outdoor or corrosive use.

Corrosive Area Finishes: Hangers and struts located in corrosive areas shall be type 304 stainless steel with stainless steel hardware.

DUCT HANGERS AND SUPPORTS

Ductwork hangers shall be fabricated of sheet metal straps in accordance with SMACNA's *HVAC Duct Construction Standards - Metal and Flexible* or of all-thread rod.

Rooftop Duct Supports: Provide roof Duct rails of G235 galvanized steel construction, 14 gauge, in compliance with ASTM A-446, 525, 526 and 527, with welded corners and 3" raised cant fully mitered with seams joined by continuous welds. Supports shall be internally reinforced with bulkheads and spreaders 24" on center, have factory installed 2 x 4 or 2 x 6 wood nailer and 18 ga. counterflashing. Height to be 12" above roof deck or as detailed on the Drawings. Support shall be level at the top with pitch built-in when deck slopes 1/4 of an inch per foot or greater.

EQUIPMENT HANGERS AND SUPPORTS

Floor-Mounted Equipment: Floor-mounted equipment shall be installed on housekeeping pad in accordance with Section 019913 and as specified above.

Suspended Equipment: For suspended equipment, the Contractor shall provide structural steel framing to distribute the imposed operating loads without stressing building structural elements or causing damage to the building substrate. Weld steel in accordance with AWS standards.

Rooftop-Mounted Equipment: Equipment shall be mounted on structural steel supports or on continuous roof curbs, as indicated on the Drawings:

Structural steel supports shall be as detailed on the Drawings.

Roof curbs shall be constructed of G235 galvanized steel, 14 gauge, in compliance ASTM A-446, 525, 526 and 527, with welded corners and 3" raised cant fully mitered with seams joined by continuous welds. Curbs shall be internally reinforced, factory insulated with 1 1/2" thick 3# density fiberglass insulation, and factory installed wood nailers fastened from underside with tek screws. Height to be 12" above roof surface. Top of all roof curbs shall be level, with pitch built into curb when deck slopes 1/4 of an inch per foot or greater. As required, provide structural steel reinforcement below roof to avoid stressing building structural elements.

PART 3 - EXECUTION

INSTALLATION OF PIPE HANGERS AND SUPPORTS

Use only one hanger type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping and to exactly fit around piping insulation for insulated piping.

Arrange for grouping of parallel runs of horizontal suspended piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacings and all-thread hanger rods sized in accordance with the following:

Nominal Pipe Size (in.)	Max. Span for Copper Tubing (ft.)	Max. Span for Steel Pipe (ft.)	Min. All-Thread Hanger Rod Size (in.)
<1	5	7	3/8
1 to 1-1/4	6	7	3/8
1-1/2	8	9	3/8
2	8	10	3/8
2 -1/2	9	10	1/2
3	10	12	1/2
4	10	12	5/8
6	10	12	3/4
8-12	10	12	7/8
14	10	12	1
18-20	10	12	1-1/4
24	10	12	1-1/2

Rigid plastic piping (ABS, PVC, CPVC, etc.) shall be suspended with adjustable band pipe hangers, MSS Type 10, with factory-fabricated, welded-in support shield. Maximum hanger spacing for rigid plastic pipe shall be 50% of the maximum span allowed for steel piping.

Where piping of various types and/or sizes is supported together by a trapeze hanger, space hangers based on the lowest maximum span allowed or install intermediate supports for pipe requiring for frequent support.

Hangers and supports for piping shall be attached to the building structure; **attachment to roof deck or cross-bracing is prohibited; attachment to other piping, ductwork, or equipment is prohibited. The use of wire or perforated strap hangers is prohibited.**

Except as allowed for uninsulated piping 2" NPS and smaller, piping installed on roofs shall be supported by pipe supports anchored to roof rails. Install and anchor pipe rails to the roof deck before roofing insulation and membrane are installed.

Pipes are to be supported within 3' of any coil connection.

INSTALLATION OF DUCT HANGERS AND SUPPORTS

Hang or support metal ductwork in accordance with Section 5 of SMACNA's *HVAC Duct Construction Standards - Metal and Flexible*. Where multiple ducts are supported by a common trapeze hanger, the trapeze shall comply with Table 5-3.

Suspend flexible ducts in accordance with SMACNA's HVAC *Duct Construction Standards - Metal and Flexible*, Figures 3-10 and 3-11.

Hangers and supports for ductwork shall be attached to the building structure; **attachment to roof deck or cross-bracing is prohibited; attachment to other ductwork, piping, or equipment is prohibited. The use of wire or perforated strap hangers is prohibited.**

Support metal duct risers with structural channels or angles at each floor. Attach structural members to the sides of the ducts with welds, bolts, of sheet metal screws.

Ductwork installed on roofs shall be supported by galvanized structural steel members or preformed channel struts, as indicated on the Drawings, installed on rooftop rails as specified for "Rooftop Pipe Supports" above. Install and anchor rooftop rails to the roof deck before roofing insulation and membrane are installed. Touch-up nicks, scrapes, cuts, etc. of galvanized supports with cold galvanizing paint. All bolts, screws, etc. for rooftop applications shall be stainless steel.

INSTALLATION OF EQUIPMENT HANGERS AND SUPPORTS

Floor-mounted equipment shall be installed level and plumb on housekeeping pads in accordance with Section 019913 and in accordance with the manufacturer's requirements.

Suspended equipment shall be supported by structural steel members or preformed channel struts with all-thread rod hangers. As required, vibration isolations required by Section 230548 shall be installed between the supports and the hangers. Suspended units shall be installed level and plumb and supported in accordance with the manufacturer's requirements.

Hangers and supports for equipment shall be attached to the building structure; **attachment to roof deck or cross-bracing is prohibited; attachment to ductwork, or piping is prohibited. The use of wire or perforated strap hangers is prohibited.**

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 230529

SECTION 230533 - HEAT TRACING FOR HVAC PIPING

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.

Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

Shop Drawings: For electric heating cable. Include plans, sections, details, and attachments to other work.

Wiring Diagrams: Power, signal, and control wiring.

PART 2 - PRODUCTS

PIPE FREEZE PROTECTION

Freeze Protection System: Shall include self-regulating heating cables, connection kits, ambient temperature control, and power distribution. The system shall provide integral GFPE protection.

Heating Element: Pair of parallel tinned stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled non-heating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

Electrical Insulating Jacket: Flame-retardant polyolefin.

Cable Cover: Stainless-steel braid, and polyolefin outer jacket with UV inhibitor.

Maximum Operating Temperature (Power On): 150 deg F.

Power Control Module:

Multipoint electronic control and monitoring system for heat-tracing piping for freeze protection. Control system to be capable of controlling of up to 5 individual heat-tracing circuits using electro-mechanical relays rated at 30A up to 277 V. Control system shall incorporate single point electrical connection at 460/3. Control panel shall be responsible for transforming power as required for individual heat-tracing circuits. Control system shall be capable of providing ground-fault and line current sensing, alarming, switching, and RTD inputs for five heat tracing circuits. Enclosure to be rated NEMA 4/12 and shall be approved for nonhazardous indoor and outdoor locations that are subject to freezing.

Electronic Monitor Station:

Controller to provide control and monitoring of electric heating cable circuits for commercial heating applications. System to be microprocessor-based, single-point commercial heating cable controller with integrated equipment ground-fault protection. Controller to be capable of being set to monitor and alarm for high and low temperature, low current, and ground-fault level. Controller to include an RS-485 communication module to remotely configure, control and monitor the heating cable circuits through a building management system (BMS).

CONTROLS

Provide remote bulb type thermostat in corrosion-resistant, waterproof control enclosure with adjustable temperature range from 30 to 50 deg F. Thermostat shall have snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.

PART 3 - EXECUTION

INSTALLATION

Install electric heating cables after piping has been tested and before insulation is installed.

Piping must be clean and dry for installation of heating cables.

Install heating tape on all water piping exposed to outdoor air in strict accordance with manufacturer's recommendations to provide the following minimum levels of heat output:

Pipe Size	Watts/Linear Foot of Piping
1/2"	1.6
3/4"	1.7
1"	1.9
1-1/4"	2.0
1-1/2"	2.3
2"	2.9
2-1/2"	3.4
3"	4.5
4"	4.9
6"	7.1
8" +	0.68/in. of pipe diameter

Install electric heating cable across expansion joints according to manufacturer's written recommendations using slack cable to allow movement without damage to cable.

Install electric heating cables according to IEEE 515.1.

Install insulation over piping with electric cables according to Section 230719

Set field-adjustable switches and circuit-breaker trip ranges.

Protect installed heating cables, including non-heating leads, from damage.

ELECTRICAL CONNECTIONS

Ground equipment and connect wiring according to Section 230511, as applicable.

FIELD QUALITY CONTROL

Perform tests after cable installation but before application of coverings, as follows:

Test cables for electrical continuity and insulation integrity before energizing.

Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounting cables.

Remove and replace malfunctioning units and retest as specified above.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 230533

SECTION 230548 – HVAC VIBRATION CONTROL

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

DEFINITIONS

Vibration Control: A fixed device used to prevent or reduce the transmission of vibration created by mechanical equipment.

Isolation Efficiency: The percentage of vibration force transmitted to the support structure. For example, 90% efficiency results in 10% of the vibration force being transmitted.

Internal Isolation: Vibration isolators that isolate only the moving parts of a piece of equipment.

External Isolation: Vibration isolators that are attached directly to the building structure and isolate the entire piece of equipment.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Product Data: Illustrate and indicate types, styles, materials, strength, fastening provisions, and finish for each type and size of vibration isolation component used.

DESIGN CRITERIA AND PERFORMANCE REQUIREMENTS

Delegated Design: **Responsibility for the selection and application of vibration isolation elements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria hereinafter specified, is delegated to the Contractor.** The professional engineer performing delegated design shall sign and seal any drawings, calculations, product selections, etc. and submit these documents to the A/E for review. Professional engineer shall be licensed in the state of North Carolina.

Performance Requirements and Design Criteria: Motor-driven equipment shall be isolated from the structure by means of resilient vibration and noise isolating supports to achieve the vibration limits imposed in Section 230510.

Supports shall be such that vibration is isolated and expansion and contraction is accommodated without creating excessive stresses in piping or equipment connections.

Isolator types and vibration bases shall be selected and sized for each equipment item in accordance with manufacturer's recommendations and in compliance with Table 47, Chapter 48, 2011 ASHRAE Handbook-*HVAC Applications*.

Examine areas and conditions under which vibration control is to be installed and the substrates that will support same. Notify A/E in writing of conditions detrimental to proper completion of the Work. Do not proceed with the Work until satisfactory conditions have been met.

Coordinate layout and installation of vibration controls with building structural system, architectural features, mechanical, electrical and fire suppression systems and other building features. Coordinate the equipment bases with the building structural system.

Comply with additional criteria and specific requirements defined in Part 2 of this Section.

PART 2 – PRODUCTS

VIBRATION ISOLATION

Corrosion Resistance: Isolators shall be designed and/or treated for resistance to corrosion, as follows:

Steel components shall be hot-dipped galvanized, PVC coated, or primer coated and painted with finish coat of industrial grade enamel.

All nuts, bolts and washers shall be hot-dipped galvanized or stainless steel.

Structural steel vibration bases shall be thoroughly cleaned of welding slag and primed with zinc-chromate or metal etching primer and a finish coat of industrial enamel applied over the primer.

Isolators exposed to the weather shall have steel parts PVC coated, hot-dipped galvanized, or zinc-electroplated, with an additional coating of neoprene or bitumastic paint. Aluminum components for outdoor installation shall be etched and painted with industrial grade enamel. Nuts, bolts and washers shall be stainless steel.

Deflection: Isolators shall be installed in such a manner that loaded deflections are compensated for initially.

Isolator Elements: Steel springs shall be open or housed type as specified with static deflection required and the capability of 30% overtravel before becoming solid. Springs shall be designed for lateral stability with a stiffness ratio of 1 except where greater horizontal thrust required greater horizontal stiffness.

Elastomers shall be rubber, neoprene, Buna N, silicone or other material to meet specific service conditions and shall be molded in the range of 30 to 60 durometer. Material shall be of color coded stock for easy identification of rated load capacity.

Precompressed fiber glass shall consist of a high density matrix of molded glass fiber encased in a waterproof neoprene jacket resistant to oil, acids and fungus and color coded for easy identification of rated load capacity.

Isolator Types: Isolators shall be applied in accordance with the "types," as follows:

Type I - Pad type mountings consisting of any one of the following constructions:

Two layers of ribbed or waffled neoprene pads bonded to a 16 gauge galvanized steel separator plate. Bolting not required. Pads shall be sized for approximately 20 to 40 psi load, or a deflection of 0.12 inch to 0.16 inch.

Precompressed fiberglass properly sized for 5 to 60 psi loading depending on density with steel plates bonded to top of isolator.

Two layers of ribbed or waffled neoprene pads bonded to vibration cork sized for 10 to 60 psi loading.

Type II - Elastomeric mountings having steel baseplate with mounting holes and a threaded insert at top of the mounting for attaching equipment. All metal parts shall be completely embedded in the elastomeric material. Mountings shall be designed for approximately 1/4 inch deflection and loaded so that deflection does not exceed 15% of the free height of the mounting.

Type III - Adjustable, freestanding, open-spring mountings with combination leveling bolt and equipment fastening bolt. Spring (or springs) shall be rigidly attached to mounting baseplate and to the spring compression plate. A neoprene pad having a minimum thickness of 1/4 inch shall be bonded to the baseplate.

Type IV - Spring hangers consisting of a rectangular steel box, elastomeric element, coil spring, spring cups, neoprene impregnated fabric washer, and steel washer. The design shall be such as to prevent metal-to-metal contact between the hanger rod and the top of the hanger box. The elastomeric element shall meet the design requirements for Type II mountings. The hanger box shall be capable of supporting a load of 200% of rated load without noticeable deformation or failure.

Vibration Bases: **Vibration bases with isolators shall be provided for motors and motor-driven equipment, whether indicated on the drawings or not.** Bases shall incorporate isolators as herein specified, shall be designed with ample rigidity to resist all starting and operating forces without supplemental hold-down devices and meet the following criteria:

All bases supporting a given piece of equipment shall be arranged for approximately equal spring deflection.

Steel bases shall be factory-fabricated, welded, structural-steel bases and rails.

Design base for the lowest possible mounting height with not less than 1-inch clearance above housekeeping pad. Include equipment anchor bolts and auxiliary motor slide bases or rails.

Structural steel shapes, plates, and bars complying with ASTM A 36. Bases shall have shape to accommodate supported equipment.

Provide factory-welded steel support brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

Inertia bases shall be factory-fabricated or field-constructed, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

Design base for lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps.

Structural steel shapes, plates, and bars complying with ASTM A 36. Bases shall have shape to accommodate supported equipment.

Provide welded steel support brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

Where height-saving brackets for side mounting of isolators and where recessed pockets for recessed mounting of isolators in inertia blocks are specified, the brackets and pockets shall be designed to provide for an operating clearance of 1 inch under the inertia base, and designed so that the isolators can be installed and removed when the operating clearance is 1 inch or less. When used with spring isolators having a deflection of 2-1/2 inches or more, the brackets and pockets shall be equipped with precompression devices to limit exposed bolt length between the top of the isolator and the underneath side of the bracket.

Piping Vibration Isolation: Flexible connectors in accordance with Section 230521 shall be installed at each pipe connection to equipment mounted on vibration isolators.

Duct Vibration Isolation: Flexible connectors in accordance with Section 233300 shall be incorporated in ductwork where connected to air moving units.

PART 3 - EXECUTION

GENERAL

Installation of vibration controls shall be in accordance with manufacturer's recommendations and building construction standards. Whenever a conflict occurs between the manufacturer or construction standards, the more stringent shall apply.

VIBRATION ISOLATORS AND BASES INSTALLATION

Base-mounted fans of 20 HP or less shall be mounted on structural steel fan and motor bases with motor slide rails and holes drilled to receive the fan and motor. The steel members shall be adequately sized to prevent distortion and misalignment of the drive, and specifically, shall be sized to limit deflection of the beam on the drive side to 0.05 inch due to starting torque. Snubbers to prevent excessive motion on starting or stopping shall be furnished, if required; however, the snubbers shall not be engaged under steady running conditions.

Base-mounted pumps smaller than 15 HP shall be mounted on factory-fabricated structural steel or cast iron pump and motor bases, with components factory-mounted.

Base-mounted fans above 20 HP and pumps 15 HP and larger shall be mounted on concrete inertia bases, consisting of a perimeter steel pouring form, reinforcing bars welded in place, bolting templates, and height-saving brackets for side mounting of the isolators. The perimeter steel members shall be structural channels having a minimum depth of 1/12 of the longest span, but not less than 6 inches deep. The base shall be sized a minimum overlap of 4 inches around the base of the equipment, and in the case of belt-driven equipment, 4 inches beyond the end of the drive shaft. Fan motors shall be mounted on motor slide rails.

Air handling units without integral mounting bases and/or vibration isolation shall be mounted on a set (two or more) of steel channel rails, to which isolators are rigidly attached. Threaded holes shall be provided for bolting equipment to the rails. Isolators shall be spaced along the rails on sufficiently close center to limit deflection of the rail to 1/360 of its length. Isolators shall be Type III less leveling feature, or Type II as specified.

MECHANICAL EQUIPMENT ANCHORAGE

Anchor equipment or equipment bases rigidly to the building structure or to a concrete housekeeping pad in accordance with Section 019913. Anchors, hanger rods, etc. shall not interfere with the required performance of isolator elements.

Where equipment with internal vibration isolation is determined by the A/E to need additional external isolation, the internal isolators shall be neutralized by bolting the isolators down or removing them and new external isolators shall be installed. Coordinate this with the equipment manufacturer for best methods.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 230548

SECTION 230553 - HVAC PAINTING AND IDENTIFICATION

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data and installation instructions.

PART 2 - PRODUCTS

PAINT FOR HVAC

Ferrous Surfaces:

1 coat of fast drying, low VOC acrylic modified medium oil alkyd universal primer
2 coats of fast drying, low VOC alkyd gloss enamel

PLASTIC LABELS FOR EQUIPMENT

General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, minimum 2-1/2" X 3/4", 1/16" thick, engraved with engraver's standard letter style of black with white letter color, minimum 1/4" high, and punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

Fasteners: Self-tapping stainless steel screws.

Content for Equipment: Equipment's designation as show on Drawings or Owner's unique equipment number. Contractor shall determine requirements prior to fabricating labels.

DUCT LABELS

Standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI A13.1 but not less than 1-1/2" high letters for ductwork and not less than 3/4" high letters for access door signs and similar operational instructions.

Content for Ductwork:

Label in accordance with service abbreviations used on the Drawings and arrow indicating flow direction.

Label duct access doors and panels, identifying the component for which access is provided. See Section 233300.

PIPE LABELS

Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1, except as hereinafter specified. Provide full-band pipe markers, extending 360 degrees around pipe at each location that attach without fasteners or adhesives.

Content: Provide minimum 1-1/4" high lettering to identify piping service using the same designations and abbreviations used on the Drawings. Include arrow indicating flow direction(s). Steam lines shall indicate pressure.

VALVE TAGS

Brass Valve Tags: Provide 0.032" thick polished brass valve tags, minimum 1-1/2" diameter, with stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener.

Valve Tag Fasteners: Provide solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

PART 3 - EXECUTION

PAINTING

Equipment specified in other sections of Division 23 to be provided with factory-applied finish painting shall not be field-painted. All finish painted equipment shall be touched up where factory paint is chipped, scratched, or otherwise damaged.

All equipment not factory finish painted shall be furnished in prime coat. All prime coated equipment shall be touched up where prime coats are chipped, scratched, or otherwise damaged. All prime coated equipment shall be thoroughly cleaned and left ready for finish painting.

All welds on both insulated and non-insulated piping shall be painted with one coat of primer. Miscellaneous black steel items such as hangers and rods, machinery supports, breechings and stacks, etc., that are not shop primed, shall be field painted with one coat of primer. All metal surfaces shall be thoroughly cleaned of rust and dirt and shall be degreased before application of primer.

Where cast iron accessories or galvanized pipe, duct, or equipment surfaces are to receive finish painting, the item shall be properly cleaned of mill residue before priming. Use primer specific to the application.

Finish painting of equipment, piping, ducts, plenums, casings, breechings, stacks, insulation, etc., located in mechanical equipment rooms and spaces where equipment, piping, etc. is exposed to view shall be provided. Where indicated or specified, existing equipment, piping, duct, etc., shall be cleaned and painted along with new work.

Equipment, vents, etc. where installed on metal roofs shall be finished/painted to match roof color.

Exposed to view non-mechanical spaces: Architect/Owner to select colors for finish painting.

Exposed to view mechanical spaces: If the Owner has an existing color schedule, the Contractor shall utilize these colors for all finish painting. Otherwise, finish colors shall be as follows:

Item		Label/Paint Color	Text Color	Identification
Piping:	Chilled Water Supply/Return	Light Blue	White	CHWS/CHWR
	Hot Water Supply/Return	Dark Red	White	HWS/HWR
	Drain Piping	Black	None	None
	Glycol Supply/Return	Purple	White	GRS/GRR
Ductwork		Haze Grey	Black	Refer to drawings

Item	Label/Paint Color	Text Color	Identification
Equipment	Haze Grey	White	Refer to drawings
All Other	ANSI A13.1		

HVAC IDENTIFICATION

Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

EQUIPMENT IDENTIFICATION

Install plastic equipment label on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide labels for each of the following general categories of equipment and operational devices:

Main control and operating valves, including safety devices and hazardous units.

Meters, gauges, thermometers and similar units.

Pumps and condensers and similar motor-driven units.

Fans, blowers, primary balancing dampers and terminal units.

Packaged HVAC central-station and zone-type units.

Filters, humidifiers, water treatment systems and similar equipment.

DUCTWORK IDENTIFICATION

Label ductwork exposed to view in mechanical equipment rooms; at each building access point in shafts, attics, etc.; or concealed above lay-in ceilings, as follows:

Near locations where ducts pass through walls or floors/ceilings, or enter non-accessible enclosures.

At access doors, manholes, and similar access points which permit view of concealed ductwork.

Near major equipment items and other points of origination and termination.

Spaced at maximum spacing of 50' along each duct run.

PIPING IDENTIFICATION

Provide pipe labels as follows wherever piping is exposed to view in finished spaces, in equipment rooms, in accessible maintenance spaces (shafts, tunnels, plenums), or concealed above lay-in ceilings. Label piping installed outdoors that is exposed to view.

Near each valve and control device.

Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch where there could be question of flow pattern.

Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
At access doors, manholes and similar access points which permit view of concealed piping.

Near major equipment items and other points of origination and termination.

Spaced at maximum spacing of 25' along each piping run.

VALVE IDENTIFICATION

Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibs, and shut-off valves at plumbing fixtures, HVAC terminal devices and similar rough-in connections of end-use fixtures and units.

List each tagged valve in valve schedule for each piping system. Mount valve tag schedule in a frame with a glass cover in the primary mechanical room and include schedule(s) as part of the operating and maintenance data defined in Section 019913.

CEILING IDENTIFICATION

For equipment located above an acoustical lay-in ceiling, provide a clear adhesive label on the ceiling grid directly below the equipment. The label shall indicate in black text the equipment designation (e.g., TU-#, AHU-#, etc.).

Provide blue colored adhesive 3/4" diameter vinyl “buttons” on the ceiling grid where valves, fire dampers, access doors, etc. are located above.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 230553

SECTION 230555 – HVAC PIPE FLUSHING, TESTING AND CLEANING

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Product Data: Submit product data for flushing and cleaning chemicals proposed for use.

Flushing Plan: Submit a flushing plan prior to the start of work. The plan shall detail how the contractor will flush each piping system in accordance with these requirements including provisions for temporary bypasses and pumps.

PART 2 – PRODUCTS (Not Used)

PART 3 - EXECUTION

GENERAL

All new water piping systems shall be flushed and tested as hereinafter specified.

All temporary equipment and materials required to perform the tests and flushes shall be the responsibility of the Contractor.

Conduct flushing and pressure and leak tests prior to connection to any existing piping or new equipment.

If any change is made to the piping systems after testing and/or flushing has occurred, the affected portion shall be retested and flushed. If any portion of the piping system fails a test, it shall be retested. If any portion of the piping system is exposed to dirt or debris after flushing, it shall be reflushed.

PIPE FLUSHING

Remove dirt and debris:

For above ground piping, prior to flushing, inspect the piping and run clean water thorough piping to remove all dirt and debris. Run clean water until the water draining from the pipe is clear and clean. Fill piping system with solution of clean water and 12% hypochlorite bleach (1 quart of bleach per 10,000 gallons of water for a residual concentration of 2-3 ppm chlorine), Nalco 2567 cleaner, or equivalent. Cleaner shall contain no trisodium phosphate.

Circulate solution for at least 24 hours and then drain system to sanitary sewer.

Drain systems and fill with clean water for pressure and leak tests.

PRESSURE AND LEAK TESTING

Prior to the start of the test, verify the maximum test pressure and duration with the pipe manufacturer. **Under no circumstances shall pipe be tested at pressures or durations that may cause damage to pipe or valves**.

Prior to pressurization, remove all air from the system. Provide vent taps at each high point in the system as needed to do so. During the pressure test, verify that no air pockets, defective materials, or leaking joints exist in the line.

Pressure test piping as follows:

Test each section of hydronic piping at the highest point in the line. **Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design operating pressure**. Test pressure shall not exceed 125 psig or the maximum pressure rating for any vessel, pump, valve, or other component in system under test, whichever is lower.

Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design operating pressure. Test pressure shall not exceed 300 psig or the maximum pressure rating for any vessel, valve, or other component in system under test, whichever is lower. Verify that stress due to pressure does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.1.

Examine each section of piping for leaks in conjunction with the pressure test for a minimum of 2 hours.

PIPE CLEANING

Systems shall be cleaned after completion of flushing and testing. **Cleaners that contain trisodium phosphate are prohibited**. Prior to initial cleaning, verify that systems have been flushed, filled, started, and vented. Add cleaner to closed systems at concentrations as recommended by the manufacturer. Remove water filter elements from the system before starting circulation.

Use neutralizer agents on recommendation of the system cleaner supplier and approval of the A/E.

Flush systems using pre-cleaning chemicals designed to remove construction deposits such as pipe dope, oils, loose mill scale, and other extraneous materials. Where existing piping is reused, evaluate existing scale condition. Add recommended dosages and recirculate for six to eight hours. Drain and flush until total alkalinity of rinse water is equal to makeup water. Drain completely and refill with treated clean water.

Remove, clean, and replace strainer screens.

Inspect, remove sludge, and flush low points and fill system with clean water after cleaning process is completed. Include disassembly of components as required.

Hot Water Systems: Add cleaner to the system water until the M alkalinity value is 250 above that of the initial fill water. Verify the M alkalinity level before and after the addition of the cleaner by means of chemical tests that are observed by the Owner's construction representative; include results of all tests in the Operating and Maintenance manuals. Apply heat while circulating, slowly raising temperature to 160°F and maintain for 12 hours minimum; vent all high points to assure 100% system circulation. Remove heat and circulate to 100°F or less; drain system as quickly as possible and refill with clean water. Circulate for 6 hours at design temperature, vent air at all high points, then drain. Refill with clean water and repeat until the system cleaner is removed and the M alkalinity level returns to normal. Remove and clean all strainers. Re-vent the system and install clean filter elements in water filters. Treat with scale and corrosion inhibitors before using the system for building heating.

Chilled Water Systems: Add cleaner to the system water until the M alkalinity value is 250 above that of the initial fill water. Verify the M alkalinity level before and after the addition of the cleaner by means of chemical tests that are observed by the Owner's construction representative; include results of all tests in the Operating and Maintenance manuals. Circulate for 48 hours, then drain system as quickly as possible. Refill with clean water, circulate for 24 hours, then drain. Refill with clean water and repeat until system cleaner is removed and the M alkalinity level returns to normal. Remove and clean all strainers. Re-vent the system and install clean filter elements in water filters. Treat with scale and corrosion inhibitors before using the system for building cooling.

CERTIFICATION

Upon completion of flushing and testing of each pipe section, provide a letter to the A/E certifying that the tests and flushes were performed in accordance with the specification; what the final results were; what the intermediate results were; and what actions were taken to correct any leaks or problems. The letter shall be signed and dated by the Contractor's representative.

END OF SECTION 230555

SECTION 230593 – HVAC TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

DESCRIPTION OF WORK

Extent of testing, adjusting, and balancing (TAB) work is includes, but is not necessarily limited to, duct systems, piping systems, and associated equipment and apparatus of HVAC work.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Certification: Submit TAB subcontractor certification.

Instrument Calibration Report: Submit calibration test results for balancing instruments.

TAB Reports: Draft and final test reports

QUALITY CONTROL

TAB work shall be completed by an independent balancing subcontractor certified by the Associated Air Balance Council (AABC) or the National Environmental Balancing Bureau (NEBB).

Commissioning of HVAC systems requires participation by the TAB subcontractor as a member of the "Commissioning Team". See Section 230510 and Division 1 for requirements.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

GENERAL

After systems have been started up and initially adjusted, the Contractor shall perform tests and accomplish the balancing necessary to provide the air and water flows indicated on the Drawings.

TAB subcontractor shall spot check systems with A/E at Final Inspection.

CERTIFIED TEST REPORTS

General: Four copies of the Draft Test and Balance Reports shall be provided to the A/E before the Final Inspection. The reports shall comply with reporting procedures defined in Chapter 13, ASHRAE Standard 111 and as hereinafter specified.

After the A/E check of the system at or before the Final Inspection, the Final Test and Balance Reports shall be provided to the A/E. **Additionally, one copy of the Final Test and Balance Report shall be submitted to the authority having jurisdiction and a copy shall be included with each copy of the Operating and Maintenance Manuals.**

Certification: Both Draft and Final Reports shall be certified by the TAB subcontractor and shall:

Be certified proof that the systems have been tested, adjusted, and balanced in accordance with the referenced standards.

Accurately represent how the systems have been installed.

Define how the systems are operating at completion of the TAB procedures.

Draft Reports: Upon completion of TAB procedures, prepare and submit draft reports for review by the A/E. Draft reports may be hand written, but must be complete, factual, and legible. Organize and format draft reports as hereinafter specified.

Final Reports: After review and verification by the field check by the A/E of the Draft Report, submit the Final Reports, organized and formatted as hereinafter specified.

Reports Format: Bind report forms complete with schematic systems diagrams and/or plans and other referenced data in reinforced, vinyl, three-ring binders.

Provide title page listing the name, address, and telephone numbers of the TAB subcontractor. Provide list of all test instruments utilized, along with last date of calibration.

Provide certification page, signed by the TAB project manager, as hereinbefore specified.

Divide contents of the binder into the following divisions, as applicable, separated by divider tabs:

General Information and Summary

Air Systems TAB

Chilled Water Systems TAB

Hot Water Systems TAB

Reports Contents:

System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

Quantities of outdoor, supply, return, and exhaust airflows.

Water flow rates.

Pipe and control valve sizes and locations.

Flow and/or Flow Balancing stations.

Location and position of balancing devices (valves, dampers, etc.)

Design Data and Test Results: For each HVAC component and system, provide design data and final adjusted test data, including but not limited to the following:

Component Data	Test Data (Design and Final Adjusted Values)
Air-Handling Units	
Identification Location Manufacturer Manufacturer model number and unit size Manufacturer's serial number Unit arrangement and class Discharge arrangement. Fan sheave make, size in inches and bore. Center-to-center dimensions of sheave, and amount of adjustments in inches Number, make, type, and size of drive belts Number, type, and size of filters Motor make, and frame type and size. Motor Horsepower and rpm. Motor volts, phase, and hertz Motor Full-load FLA and service factor Motor sheave make, size in inches and bore	Air flow rate in cfm System static pressure in inches wg Fan rpm. Discharge static pressure in inches wg. Filter static-pressure differential in inches wg Preheat-coil static-pressure differential in inches wg Cooling-coil static-pressure differential in inches wg Heating-coil static-pressure differential in inches wg Outdoor airflow in cfm Return airflow in cfm Outdoor-air damper position Return-air damper position Outdoor-air, wet- and dry-bulb temperatures in deg F Return air, wet- and dry-bulb temperatures in deg F Vortex damper position Coils: See requirements below
Rooftop Units	
Identification Location Manufacturer Manufacturer model number and unit size Manufacturer's serial number Unit arrangement and class Discharge arrangement. Fan sheave make, size in inches and bore. Center-to-center dimensions of sheave, and amount of adjustments in inches Number, make, type, and size of drive belts Number, type, and size of filters Motor make, and frame type and size. Motor Horsepower and rpm. Motor volts, phase, and hertz Motor Full-load FLA and service factor Motor sheave make, size in inches and bore	Air flow rate in cfm System static pressure in inches wg Fan rpm. Discharge static pressure in inches wg. Outdoor airflow in cfm Return airflow in cfm Outdoor-air damper position Return-air damper position Outdoor-air, wet- and dry-bulb temperatures in deg F Return air, wet- and dry-bulb temperatures in deg F Vortex damper position Coils: See requirements below
Water/Refrigerant Coils	
Identification Location Coil type (Water, Refrigerant) Number of rows Fin spacing in fins per inch Make and model number Face area in sq. ft. Tube size in NPS Tube and fin materials. Circuiting arrangement.	Air flow rate in cfm Average face velocity in fpm Air pressure drop in inches wg Entering-air, wet- and dry-bulb temperatures in deg F Leaving-air, wet- and dry-bulb temperatures in deg F Water flow rate in gpm Water pressure differential in feet of head or psig Entering-water temperature in deg F Leaving-water temperature in deg F Refrigerant expansion valve and refrigerant types. Refrigerant suction pressure in psig Refrigerant suction temperature in deg F
Fans	
Identification Location Fan type Manufacturer Manufacturer model number and size	Total airflow rate in cfm Total system static pressure in inches wg Fan rpm Discharge static pressure in inches wg Suction static pressure in inches wg

Component Data	Test Data (Design and Final Adjusted Values)
Manufacturer's serial number Arrangement and class Fan sheave make, size in inches and bore Center-to-center dimensions of sheave, and amount of adjustments in inches Motor make, and frame type and size. Motor horsepower and rpm. Motor FLA and service factor Motor sheave make, size in inches and bore. Center-to-center dimensions of sheave, and amount of adjustments in inches Number, make, and size of belts	
Duct Traverse	
Identification (referenced to system diagrams included in TAB reports) System, air-handling-unit, and/or fan identification	Location and zone. Traverse air temperature in deg F Duct static pressure in inches wg Duct size in inches Duct area in sq. ft. Air flow rate in cfm Air velocity in fpm
Air Terminal Device (Register, Grille, Diffuser, etc.)	
System and air-handling unit identification Room/area served Number from system diagram. Manufacturer Type and manufacturer's model number. Size (face and neck) Effective area in sq. ft.	Test method Design air flow rate in cfm Design air velocity in fpm Preliminary measured air flow rate in cfm Preliminary measured velocity in fpm Final air flow rate in cfm Final velocity in fpm Space temperature in deg F
Pumps	
Identification Location Service Manufacturer Manufacturer model number and serial number Required net positive suction head in feet of head or psig Pump rpm Motor make and frame size Motor horsepower and rpm Motor and service factor Seal type	Static head in feet of head or psig Pump shutoff pressure in feet of head or psig Impeller size in inches Flow rate in gpm Total pressure in feet of head or psig Discharge pressure in feet of head or psig Suction pressure in feet of head or psig Motor voltage at each connection Motor amps for each phase
Air Terminal Unit	
Identification Location Rooms or area served Type (constant volume, variable volume, fan powered, etc.) Manufacturer Manufacturer model number and serial number Fan motor horsepower and rpm Fan motor FLA and service factor	Supply Air: Maximum airflow in cfm Minimum airflow in cfm Primary Air: Maximum airflow in cfm Minimum airflow in cfm Reheat Coil: See coil requirements above.
Ductless Split System	
Identification	Air flow rate in cfm

Component Data	Test Data (Design and Final Adjusted Values)
Location Manufacturer Manufacturer model number and unit size Manufacturer's serial number Number, type, and size of filters Motor make, and frame type and size. Motor Horsepower and rpm. Motor volts, phase, and hertz Motor Full-load FLA and service factor	Coils: See requirements

For Conservation Workroom 258E variable speed exhaust fans shall be balanced to each of the states below and the associated speed recorded for controls contractor. Refer to section 230993 for intended sequence of operations.

EF-1.1	EF-1.2	EF-1.3	EF-1.4
5,000 CFM	5,000 CFM	1,600 CFM	300 CFM
10,000 CFM	10,000 CFM	1,900 CFM	600 CFM
		1,300 CFM	

TEST AND BALANCE PROCEDURES

Test Instruments Calibration: Instruments for air and water test and balance shall have been calibrated within a period of six months prior to balancing and tested for accuracy prior to start of work. Calibrate vibrometer utilized for vibration testing before each day of testing using calibrator provided with the meter. Calibrate sound meters before each day of testing using calibrator complying with ANSI S1.40 and NIST certification.

Air Systems Test and Balance Procedures:

General: Air handling and distribution systems, including supply, return, ventilation, and exhaust airflows shall be balanced and adjusted in accordance with Chapter 10 of ASHRAE Standard 111 and Section 7.2.2 of ASHRAE Standard 62.1. Maximum air quantities at each outlet or inlet shall not vary more than -5% to +10% from those indicated on the Drawings.

Drive Changes: If the measured cfm of a supply fan, return fan, or exhaust fan varies more than plus 10% or minus 5% from design, adjust the drive of each fan to obtain required cfm. **Any changes in the pulleys, belts and dampers required for correct balance shall be provided by the Contractor, including replacement of fan and/or motor sheaves.**

Water Systems Test and Balance Procedures: Water circuits shall be adjusted for proper flow in accordance with Chapter 11 of ASHRAE Standard 111, within plus or minus 10% of design values.

A/E QUALITY CONTROL CHECK

In the presence of the A/E during or before the Final Inspection, the TAB subcontractor shall verify the balance of the air and water systems as follows:

Each air handler will be checked for proper airflow by an anemometer traverse on the entering side of the cooling coil.

Water flow will be tested by evaluating pressure drops across chillers, coils, etc.
At least 15% of registers, grilles, and diffusers will be checked for proper air flow via calibrated flow hood..

The TAB subcontractor shall provide all test instruments required for the Owner/Engineer check of the air and water systems balance.

During the A/E check, the TAB contractor shall verify the full range of air and water flows for the items selected to be checked. The Contractor shall have the controls sub-contractor present during the A/E check of the air and water systems balance.

END OF SECTION 230593

SECTION 230713 - HVAC DUCT INSULATION

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Flame/Smoke Ratings: Provide composite duct insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 225) method.

> Exception: Outdoor HVAC ductwork insulation may have flame spread index of 75 and smoke developed index of 150.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.

Samples: Submit, as requested by A-E, manufacturer's sample of each duct insulation type required. Affix label to sample completely describing product.

PART 2 - PRODUCTS

INSULATION MATERIALS

Mineral Fiber Insulation: Insulation made up of fibers manufactured of glass, rock, or slag, processed from the molten state, with or without a binder.

> Mineral Fiber Board Insulation: ASTM C 612, Type IA or IB, with factory-applied jacket. Insulation density shall be 3.0 pcf or greater and conductivity, k, tested in accordance with ASTM C 518 or C 177 at 75ºF mean temperature shall not exceed 0.25 Btu-in./(hr-sf-ºF).
>
> Mineral Fiber Blanket Insulation: ASTM C 553, Type II, with factory-applied jacket. Insulation density shall be 1.00 pcf and conductivity, k, tested in accordance with ASTM C 518 or C 177 at 75ºF mean temperature shall not exceed 0.27 Btu-in./(hr-sf-ºF).
>
> Factory-Applied Jacket for Mineral Fiber Insulation: Jacket and tape shall comply with ASTM C 1136, Type II, as follows:
>
> > FSP Jacket: Jacket consisting of aluminum foil, fiberglass-reinforced scrim with polyethylene backing.

FSK Jacket: Jacket consisting of aluminum foil, fiberglass-reinforced scrim with kraft-paper backing.

Jacket Tape: Seams and tears/damage to jacket shall be sealed with foil-face, vapor-retarder type tape matching the factory-applied jacket, with acrylic adhesive, 3" wide, and not less than 6.5 mils thick.

Polyisocyanurate Foam Board Insulation: Rigid board material manufactured from closed cell, polyisocyanurate foam between two aluminum foil facers, complying with ASTM C 1289 Type 1, Class 2, with Grade 2 minimum compressive strength.

Adhesives shall be water-based, low VOC type complying with ASTM C 916.

JACKETING MATERIAL

Insulated outdoor ductwork shall have field-applied embossed or corrugated aluminum jacket 0.016" thick in accordance with ASTM B209, 3003 alloy, H-14 temper, banded on 8” centers. It shall have a 3-mil thick heat bonded polyethylene and kraft-paper moisture barrier.

PART 3 - EXECUTION

INSULATION APPLICATION

Indoor ductwork shall be insulated as follows:

Ductwork exposed to view in mechanical equipment rooms, etc. shall be insulated with 2” thick mineral fiber board insulation.

Concealed ductwork shall be insulated with 2” thick mineral fiber blanket insulation except 6” wide board insulation at trapeze hangers.

Outdoor ductwork shall be insulated with 3" thick polyisocyanuarate insulation. **Mineral fiber insulation shall not be applied to outdoor ductwork.**

Insulate the following ductwork and plenums:

Supply air, including back side of air outlets
Return air
LEX-1 ductwork located outdoors.
Outside air
Exhaust air located in unconditioned spaces, including attics, crawl spaces, basements, mechanical rooms, roof, etc.

Exceptions: Do not insulate the following:

Flexible connections at fans or equipment
Factory-insulated flexible ductwork

GENERAL INSTALLATION REQUIREMENTS

Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

Install insulation with longitudinal seams at top and bottom of horizontal runs.

Install multiple layers of insulation with longitudinal and end seams staggered.

Keep insulation materials dry during application and finishing.

Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

Install insulation with least number of joints practical.

Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

Install insulation continuously through hangers and around anchor attachments. Extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

Install insulation with factory-applied jackets as follows:

Draw jacket tight and smooth.

Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket.

Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c. Tape laps with 3" wide foil tape.

For below ambient services, apply vapor-barrier mastic over staples.

Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal. Apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

INSTALLATION AT PENETRATIONS

Roof Penetrations: Install insulation continuously through roof penetrations.

Seal penetrations with flashing sealant.

For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.

Seal jacket to roof flashing with flashing sealant.

Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

Seal penetrations with flashing sealant.

For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.

Seal jacket to wall flashing with flashing sealant.

Interior Wall and Partition Penetrations, Not Fire Rated: Install insulation continuously through walls and partitions.

Fire-Rated Wall, Partition, and Floor Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches. Comply with requirements 019913 for firestopping and fire-resistive joint sealers.

INSTALLATION OF MINERAL FIBER INSULATION

Blanket Mineral Fiber Insulation Installation: Secure with adhesive and insulation pins, as follows:

Apply adhesives according to manufacturer's recommended coverage rates per unit area of duct and plenum surfaces.

Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts. **Adhesive secured pins are prohibited.** Pins shall be installed as follows:

On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.

On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.

Do not overcompress insulation during installation.

Impale insulation over pins and attach speed washers.

Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface.

Cover exposed pins and washers with 3" long piece of 3" wide foil continuous vapor barrier tape.

For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.

Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface.

Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

Board Mineral Fiber Insulation Installation: Secure with adhesive and insulation pins in accordance with the requirements for blanket insulation above, with the following modifications:

For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

INSTALLATION OF POLYISOCYANURATE INSULATION

Polyisocyanurate Board Insulation Installation: Secure with adhesive and insulation pins:

Apply adhesives according to manufacturer's recommended coverage rates per unit area of duct and plenum surfaces.

Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts. **Adhesive secured pins are prohibited.** Pins shall be installed as follows:

On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.

On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.

Do not compress insulation during installation.

Impale insulation over pins and attach speed washers.

Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface.

Cover each exposed pin and washer with 3" long piece of 3" wide foil continuous vapor barrier tape.

For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Seal both longitudinal seams and butt joints with adhesive and install 3" wide foil continuous vapor barrier tape over them.

Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

Outdoor Ductwork Additional Weather Jacket: Insulation on outdoor ductwork shall be protected by a covering with minimum 20 gauge aluminum complying with ASTM B 209, Alloy 3003, Temper H-14 arranged so that sides are flashed under the top and the bottom is flanged, turned down, and mechanically attached to the sides. All transverse joints shall be made with a minimum ½" standing seam, mechanically closed and caulked watertight with flexible mastic. See Drawings for construction details.

EXISTING INSULATION REPAIR

Repair damaged sections of existing duct or plenum insulation damaged during this construction period. Use insulation of same thickness as existing insulation, install new jacket lapping and sealed over existing.

END OF SECTION 230713

SECTION 230716 - HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 225) method.

> Exception: Outdoor mechanical insulation may have maximum flame spread index of 75 and smoke developed index of 150.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each HVAC equipment item requiring insulation.

Samples: Submit, if requested by A-E, manufacturer's sample of each equipment insulation type required. Affix label to sample completely describing product.

PART 2 - PRODUCTS

EQUIPMENT INSULATION MATERIALS

Mineral Fiber Insulation: Insulation made up of fibers manufactured of glass, rock, or slag, processed from the molten state, with or without a binder.

> Mineral Fiber Board Insulation: Comply with ASTM C 612, Type IA or IB, without factory-applied jacket. Insulation density shall be 3.0 pcf or greater and conductivity, k, tested in accordance with ASTM C 518 or C 177 at 75ºF mean temperature shall not exceed 0.25 Btu-in./(hr-sf-ºF).
>
> High Temperature Mineral Fiber Board Insulation: Comply with ASTM C 612, Type III, without factory-applied jacket. Insulation density shall be 3.0 pcf or greater and conductivity, k, tested in accordance with ASTM C 518 or C 177 at 75ºF mean temperature shall not exceed 0.25 Btu-in./(hr-sf-ºF).
>
> Factory-Applied Jacket: Provide factor-applied jacket in accordance with Section 230713 when insulated equipment is operating at temperatures below ambient.

Calcium Silicate Insulation: Flat, curved, or grooved block sections of noncombustible, inorganic, hydrous calcium silicate with non-asbestos fiber reinforcement in accordance with ASTM C 533, Type I, without factory jacket

Cellular Glass Insulation: Block foamed or cellulated glass with annealed, rigid, hermetically sealed closed cells in accordance with ASTM C 552, Type II, Class 2, without factory jacket

Polyisocyanurate Foam Board Insulation: Rigid board material manufactured from closed cell, polyisocyanurate foam aluminum foil facers, complying with ASTM C 1289 Type 1, Class 2, with Grade 2 minimum compressive strength.

Polystryrene Foam Insulation: Unfaced, preformed rigid cellular material complying with ASTM C578, Type IV, except that thermal conductivity shall not exceed 0.26 Btu-in/hr-SF-F at 75 F after 180 days of aging.

Jacketing Material for Equipment Insulation: Insulated equipment exposed to view shall have field-applied jacket as follows:

Encase all equipment insulation with glossy, 20-mil high impact UV- resistant PVC jacket meeting requirements of ASTM D 1784, Class 16353-C. **Jackets shall have integral colors as required by Section 230553.**

Exceptions:

Insulated exposed outdoor equipment insulation shall be with embossed or corrugated aluminum jacket 0.016" thick in accordance with ASTM B209, 3003 alloy, H-14 temper with 3-mil thick heat bonded polyethylene and kraft-paper moisture barrier.

PART 3 - EXECUTION

EQUIPMENT INSULATION AND JACKET APPLICATION

Cold Equipment (Below Ambient Temperature):

Application Requirements: Insulate the following cold equipment:

Drip pans under chilled equipment.

Chilled water pumps.

Insulate with the following types and thicknesses of insulation:

Cellular Glass: 3" thick for surfaces above 35 deg. F and 4-1/2" thick for surfaces 35 deg. F and lower.

Exceptions:

Cellular glass, 3" thick, shall be utilized to insulate beneath chilled water coil bank drain pans.

Outdoor equipment shall be insulated with polyisocynaurate foam insulation, with the same thickness as insulation hereinbefore specified, or with polystyrene foam insulation, with thickness 1" greater than insulation hereinbefore specified.

Hot Equipment (Above Ambient Temperature):

Application Requirements: Insulate the following hot equipment:

Coil assemblies located in air stream.

Hot water pumps.

Insulate with one of the following types and thicknesses of insulation:

Mineral fiber: 2" thick

Calcium Silicate: 3" thick

Exception: Outdoor equipment shall be insulated with polyisocyanurate or polystyrene foam insulation, with thickness 1" greater than mineral fiber insulation hereinbefore specified **if operating temperature does not exceed insulation maximum rated service temperature.**

GENERAL INSTALLATION REQUIREMENTS

Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the surface area of equipment.

Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment as specified in insulation system schedules.

Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

Install insulation with longitudinal seams at top and bottom of horizontal runs.

Install multiple layers of insulation with longitudinal and end seams staggered.

Keep insulation materials dry during application and finishing.

Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
Install insulation with least number of joints practical.

Where vapor barrier is required, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

Install insulation continuously through hangers and around anchor attachments.

For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

Install insulation with factory-applied jackets as follows:

Draw jacket tight and smooth.

Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket.

Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

For below ambient services, apply vapor-barrier mastic over staples.

Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.

Where vapor barriers are required, apply vapor-barrier mastic on seams and joints.

Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

Repair damaged insulation replacing insulation. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

For above ambient services, do not install insulation to the following:

Vibration-control devices.

Testing agency labels and stamps.

Nameplates and data plates.
Manholes.

Handholes.

BOARD INSULATION INSTALLATION

Apply adhesives according to manufacturer's recommended coverage rates per unit area for coverage of tank and vessel surfaces.

Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.

Protect exposed corners with secured corner angles.

Install pins and speed washers on sides of equipment as follows:

Do not weld anchor pins to ASME-labeled pressure vessels. For non-labeled vessels and equipment, install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins.

Select insulation adhesives that are compatible with service temperature and with substrate.

Maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.

Anchor insulation with speed washers; do not compress insulation during installation.

Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.

Impale insulation over anchor pins and attach speed washers.

Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.

Where insulation of hangers on equipment and vessels is not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.

Stagger joints between insulation layers at least 3 inches.

Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.

Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.

For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation. Cover joints with 3" wide foil tape vapor barrier.

INSTALLATION OF CALCIUM SILICATE INSULATION

Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation material.

Install two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner

Layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.

On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth. thin finish coat to achieve smooth, uniform finish.

INSULATION INSTALLATION ON PUMPS

Fabricate minimum 18 ga. aluminum boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch-diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.

Aluminum sheet for boxes shall comply with ASTM B 209, Alloy 3003, Temper H14. Finish shall be embossed or corrugated to match adjacent piping.

For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

FIELD-APPLIED JACKET INSTALLATION

Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

EXISTING INSULATION REPAIR

Repair damaged sections of existing mechanical insulation damaged during this construction period. Use insulation of same thickness as existing insulation, install new jacket lapping and sealed over existing.

END OF SECTION 230716

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 225) method.

> Exception: Outdoor mechanical insulation may have flame spread index of 75 and smoke developed index of 150.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.

Samples: Submit, as requested by A-E, manufacturer's sample of each piping insulation type required. Affix label to sample completely describing product.

PART 2 - PRODUCTS

PIPING INSULATION MATERIALS

Mineral Fiber Insulation:

> Insulation shall be made of fibers manufactured from glass, rock, or slag, processed from the molten state, with or without a binder.
>
> Insulation shall be heavy density pre-formed sectional type for piping in accordance with ASTM C 547, Class I, factory-jacketed.
>
> Glass fiber insulation shall be rated for fluid temperature up to 850-degrees F.
>
> Mineral wool insulation shall be rated for fluid temperature to 1200-degrees F.

Cellular Glass Insulation: Pre-formed sections of foamed or cellulated glass with annealed, rigid, hermetically sealed closed cells in accordance with ASTM C 552, Type II, Class 2, factory-jacketed.

Closed Cell, Flexible Elastomeric Insulation: Flexible elastomeric, closed cell, thermal insulation in accordance with ASTM C534, Type I, preformed tubes, black in color, rated for piping temperatures to 220 degrees F. Insulation shall be AP/Armaflex or equivalent.

Polyisocyanurate Insulation: Preformed pipe and fitting closed cell foam insulation, ASTM C 591, Type IV, K=0.027 Btu-in/hr-SF-°F, for use at temperatures up to 300°F. Supply insulation with factory-applied vapor retarder/vapor barrier with jacket as hereinafter specified. **Insulation with pre-applied adhesive is prohibited.**

Polystyrene Insulation: Insulation shall be closed cell foam insulation, pre-formed into sections complying with ASTM C578, Type IV, except that thermal conductivity shall exceed 0.26 Btu-in/hr-SF-F at 75 F after 180 days of aging.

Jackets for Piping Insulation: Insulation jackets shall be all-service vapor retarder type as follows:

Piping Operating at Temperatures Above Ambient: Jacket shall be "ASJ" type, consisting of white, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

Piping Operating at Temperatures Below Ambient: Jacket shall be one of the following:

FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.

Exceptions:

Piping insulated with cellular glass, polyisocyanurate, or polystyrene may have ASJ jacket.

Covering for Piping Insulation Exposed to View:

Encase Temperature Range 1A and 3 indoor straight piping insulation with glossy, 20-mil high impact UV-resistant PVC jacket meeting requirements of ASTM D 1784, Class 16353-C. **Jackets shall have integral colors as required by Section 230553.**

Encase all indoor pipe fittings insulation with one-piece pre-molded 20-mil UV-inhibited PVC fitting covers complying with ASTM C450 for dimensions and fastened as per manufacturer's recommendations.

Encase all outdoor straight piping insulation with embossed or corrugated 0.016" thick aluminum jacket in accordance with ASTM B209, 3003 alloy, H-14 temper, banded on 8” centers. It shall have a 3-mil thick heat bonded polyethylene and kraft-paper moisture barrier.

Encase all outdoor pipe fittings insulation with pre-formed, factory-fabricated, 0.016" thick aluminum fitting covers to match adjacent straight piping jacket.

Exception: Indoor flexible elastomeric insulation exposed to view in mechanical rooms shall not be covered.

PART 3 - EXECUTION

PIPING SYSTEM INSULATION APPLICATIONS

Piping systems shall be classified in accordance with MSS SP-58, as follows, and be insulated as hereinafter specified:

Classification	Temperature Range (deg F)
Type 1: Hot Systems	Type 1A: 120-200
Type 3: Cold Systems	Type 3A: 32-70
	Type 3B: <32

Classification Type 1A Piping: Insulate the following HVAC piping systems:

HVAC hot water supply and return piping.

Hot gas refrigerant piping.

Hot water safety valve discharge piping.

Insulate with mineral fiber insulation to the following minimum thickness:

Up through 1-1/4" IPS	1-1/2"
1-1/2" IPS and larger	2"

Exceptions:

Outdoor piping shall be insulated with polyisocyanurate or polystyrene foam insulation, with 1" greater thickness as mineral fiber insulation hereinbefore specified **if operating temperature does not exceed insulation maximum rated service temperature.**

Classification Type 3A Piping: Insulate the following cold HVAC piping systems:

Chilled water supply and return piping.

Cooling coil condensate drain piping.

Insulate indoor piping with cellular glass insulation, 2" thick for pipe sizes up to and including 4", 3" thick for pipe sizes over 4".

Insulate outdoor piping with additional 1" thickness of insulation.

Exceptions:

Outdoor piping may be insulated with polyisocyanurate foam insulation, with the same thickness as insulation hereinbefore specified, or with polystyrene foam insulation, with thickness 1" greater than insulation hereinbefore specified.

Indoor Type 3A piping 1" NPS and smaller may be insulated with 1" thick flexible elastomeric insulation.

Condensate drain piping within mechanical equipment rooms may be insulated with 1" thick flexible elastomeric insulation.

Classification Type 3B Piping: Insulate the following cold HVAC piping systems:

Refrigerant suction lines between evaporators and compressors.
Insulate with fiberglass, 1" thick for pipe sizes up to and including 1", 1-1/2" thick for pipe sizes over 1".

Exception: Refrigerant suction piping may be insulated with ¾" thick flexible elastomeric insulation.

GENERAL INSTALLATION REQUIREMENTS

For Classification Type 1 piping, do not insulate valves, strainers, unions, etc. unless indicated hereinafter.

For Classification Type 3 piping, install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.

Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

Insulate pipe elbows using preformed fitting insulation or mitered sections made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

Install removable insulation covers for valves and piping specialties and where indicated on the Drawings. Installation shall conform to the following:

Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

Install insulation accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state. Install insulation with longitudinal seams at top and bottom of horizontal runs.

Install multiple layers of insulation with longitudinal and end seams staggered. Do not weld pins, clips, or other insulation attachment devices to piping, fittings, and specialties.

Keep insulation materials dry during application and finishing.

Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

Install insulation with least number of joints practical.

Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

Install insulation continuously through hangers and around anchor attachments:

At pipe hangers and supports, protect the insulation from compression as follows:

Piping Classification Type 1A, 2, and 3 shall be insulated with cellular glass piping insulation for the length of the insulation shield specified in Section 230529. Insulation vapor barrier shall be lapped and sealed in accordance with manufacturer’s instructions to maintain continuous vapor barrier integrity.

Piping Classification Type 1B, 1C, and/or 1D shall have piping insulation and jacket cut to butt the piping saddle specified in Section 230529. Saddle shall rest directly on the hanger.

Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

Install insulation with factory-applied jackets as follows:

Draw jacket tight and smooth.

Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket.

Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

For below-ambient services, apply vapor-barrier mastic over staples.

Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.

Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

Outdoor piping shall be covered by vapor barrier and exterior (weatherproofing) jacket as soon as possible after the insulation has been installed. All polyisocyanurate and/or polystyrene materials applied in one day shall have their vapor barrier installed the same day. Any exposed insulation shall be temporarily protected with a combination moisture and UV barrier (such as 6 mil black polyethylene film) to keep out moisture. Mastics shall not be applied with the ambient air temperature is below 40° F or is expected to be below 40° F within 24 hours of the application.

INSULATION INSTALLATION AT PENETRATIONS

Roof Penetrations: Install insulation continuously through roof penetrations.

Seal penetrations with flashing sealant.

For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.

Seal jacket to roof flashing with flashing sealant.

Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

Seal penetrations with flashing sealant.

For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.

Seal jacket to wall flashing with flashing sealant.

Interior Wall, Partition, and Floor Penetrations: Install insulation continuously through walls, partitions, and floors. Seal penetrations through fire-rated assemblies complying with requirements of Section 019913 for firestopping and fire-resistive joint sealers.

INSTALLATION OF CELLULAR GLASS INSULATION

Insulation Installation on Straight Pipes and Tubes:

Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

Insulation Installation on Pipe Flanges:

Install preformed pipe insulation to outer diameter of pipe flange.
Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.

Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch and seal joints with flashing sealant.

Insulation Installation on Pipe Fittings and Elbows:

Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

Insulation Installation on Valves and Pipe Specialties:

Install preformed sections of cellular-glass insulation to valve body.

Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

Install insulation to flanges as specified for flange insulation application.

INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

Flexible elastomeric insulation shall be installed in strict accordance with the manufacturer's written installation instructions.

Insulation Installation on Straight Pipes and Tubes:

Install un-slit insulation sections to the maximum extent possible. Seal butt joints with manufacturer's recommended adhesive.

Where slit insulation sections must be used, seal longitudinal seams and butt joints with manufacturer's recommended adhesive. **Secure slit sections on both sides of each fitting and 12" o.c. on straight pipe or tubing runs with 2" wide, 1/8" thick insulation tape matching the adjacent insulation. The use of metal bands, plastic bands, and wire are prohibited.**

Insulation Installation on Pipe Flanges:

Install pipe insulation to outer diameter of pipe flange.

Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

Insulation Installation on Pipe Fittings and Elbows:

Fabricate mitered sections of pipe insulation as fitting covers.

On soldered, brazed, or buttwelded joint fittings, insulation that fits the adjacent piping may be used.

For screwed or socket weld joint fittings, the insulation inside diameter shall match the outside diameter of the adjacent piping. Fitting covers shall lap adjacent piping insulation by at least 1".

Secure insulation materials and seal longitudinal seams and butt joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

Insulation Installation on Valves and Pipe Specialties:

Install preformed valve covers manufactured of same material as pipe insulation when available.

When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

Install insulation to flanges as specified for flange insulation application.

Secure insulation to valves and specialties and seal longitudinal seams and butt joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

Insulation installed outdoors shall be painted with two coats of UV-inhibiting coating recommended by the insulation manufacturer.

INSTALLATION OF MINERAL FIBER INSULATION

Insulation Installation on Straight Pipes and Tubes:

Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.

For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

Insulation Installation on Pipe Flanges:

Install preformed pipe insulation to outer diameter of pipe flange.

Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.

Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

Insulation Installation on Pipe Fittings and Elbows:

Install preformed sections of same material as straight segments of pipe insulation when available.

When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

Insulation Installation on Valves and Pipe Specialties:

Install preformed sections of same material as straight segments of pipe insulation when available.

When preformed sections are not available, install mitered sections of pipe insulation to valve body.

Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
Install insulation to flanges as specified for flange insulation application.

INSTALLATION OF POLYISOCYANURATE INSULATION

Insulation Installation on Straight Pipes and Tubes:

Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials.
Orient longitudinal joints between half sections in 3- and 9-o'clock positions on the pipe.

For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.

All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

Insulation Installation on Pipe Flanges:

Install preformed pipe insulation to outer diameter of pipe flange.

Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch thickness.

Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as pipe insulation.

Insulation Installation on Fittings and Elbows: Install preformed sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

Insulation Installation on Valves and Pipe Specialties:

Install preformed sections of polyisocyanurate insulation to valve body.

Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

Install insulation to flanges as specified for flange insulation application.

INSTALLATION OF POLYSTYRENE INSULATION

Insulation Installation on Straight Pipes and Tubes:

Secure each layer of insulation with tape or bands and tighten bands without deforming insulation materials.
Orient longitudinal joints between half sections in 3- and 9-o'clock positions on the pipe.

For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.

All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

Insulation Installation on Pipe Flanges:

Install preformed pipe insulation to outer diameter of pipe flange.
Make width of insulation section same as overall width of flange and bolts, and make thickness same as adjacent pipe insulation, not to exceed 1-1/2-inch.

Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polystyrene block insulation of same thickness as pipe insulation.

Insulation Installation on Pipe Fittings and Elbows: Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

Insulation Installation on Valves and Pipe Specialties:

Install preformed section of polystyrene insulation to valve body.

Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

Install insulation to flanges as specified for flange insulation application.

FIELD-APPLIED JACKET INSTALLATION

Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.

Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.

Completely encapsulate insulation with coating, leaving no exposed insulation.

Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water and located at 4 o'clock position. Seal end joints, laps, gauges, thermometers and other devices with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

EXISTING INSULATION REPAIR

Repair damaged sections of existing mechanical insulation damaged during this construction period. Use insulation of same thickness as existing insulation, install new jacket lapping and sealed over existing.

END OF SECTION 230719

SECTION 230913 - INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to the work of this section.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data and installation instructions for all components including the following to demonstrate compliance with the contract documents:

Catalog cut sheets of all equipment used. This includes, but is not limited to sensors, actuators, valves, and dampers.

Catalog cut sheets of air measuring stations used for the volumetric control system. Include as a separate volumetric control section velocity transmitters, static pressure transmitters, and flow chart for sequence of operation.

As applicable, control air supply components and sizing computations for compressors, receivers, and main air piping.

Operation and Maintenance (O/M) Manuals: See Section 019913 for requirements. O/M manuals shall include the following, at a minimum, elements:

General description and specifications for all sensors and final control elements.

Complete troubleshooting procedures and guidelines for all sensors and final control elements.

Documentation of all required maintenance and repair/replacement procedures.

PART 2 -PRODUCTS

ELECTRONIC SENSORS

General: Provide all remote sensors and instrumentation as required for the control system. All sensors shall have accuracies as stated hereinafter. Electronic sensors shall include integral transmitter and provide input analog input signal as either 4-20 mA or 0-10 VDC over the full range specified below.

Sensor Accuracy and Range: Each electronic sensor shall have accuracy and range as follows:

Sensed/Measured Variable	Sensor Characteristics Required	
	Measurement Accuracy	Range
Space Temperature	±1°F	+50°F- +85°F
Outside Air Temperature	±2°F	-30°F- +130°F
Relative Humidity (indoor air)	±5% RH	20% - 80% RH
Relative Humidity (outdoor air)	±2% RH	10% - 95% RH
Ducted Air Temperature	±1°F	+40°F- +140°F
Airflow (terminal)	±10% of full scale	
Airflow (fan total)	±5% of full scale	
Air Pressure (ducts)	±0.1 in. w.g.	0 - 5.0 in. w.g.
Air Pressure (space)	±0.01 in. w.g.	-0.25 - 0.25 in. w.g.
Water Temperature		
- Chilled Water	±1°F	+20°F- +70°F
- Hot Water	±1°F	+50°F- +250°F
Water Differential Pressure	±2 psig	0-30 psig

Temperature Sensors:

Space Sensors: Space sensors within the conservation area shall RTD type with integral transmitter within wall-mounted enclosures.

Space Sensors: Space sensors shall be negative temperature coefficient thermistor type within wall-mounted enclosures with blank covers and no temperature display. No setpoint adjustment by occupants shall be provided. Select thermistor resistance and temperature/resistance curve for maximum accuracy in the range of 50-100 deg F.

Duct-mounted Sensors: Sensors shall be RTD type averaging sensors with integral transmitter and a sensing element incorporated in a copper capillary with a minimum length of 20 feet.

Hydronic Pipe Insertion Sensors: Sensors shall be RTD with integral transmitter, stem or tip sensitive type as required. Sensing elements shall be hermetically sealed. Stem and tip construction shall be 304 stainless steel, copper, glass or epoxy. All external trim material shall be corrosion resistant designed for the intended application. Sensor pipe wells shall be of bronze, stainless steel, copper, or monel materials. Heat transfer compounds shall be compatible with the sensors.

Indoor Air Relative Humidity Sensors: Analog type with polymer element for comfort conditions monitoring and platinum element for critical areas including laboratories, hospital procedure rooms, etc. Space sensors shall have blank covers and no humidity display and no setpoint adjustment unless specifically indicated on the drawings. Duct sensors shall meet the requirements specified below for outdoor relative humidity sensors.

Outdoor Air Relative Humidity Sensors: Relative humidity sensors installed outdoors or in HVAC ductwork shall utilize a platinum or ceramic capacitive sensing element that is impervious to damage by (1) humidity levels exceeding 95% RH and (2) wetting by rain or surface condensation. Measurement range shall be 10 - 95% RH within a temperature range of -40ºF to 140ºF. Sensors installed in outdoors shall include a weatherproof enclosure. Motor Status Sensor: Status of pumps and fans shall be proven by adjustable current sensing relays. Provide user adjustable time delays (10 seconds default) to prevent false alarms during starting/stopping of motor.

Pressure and Differential Pressure Sensors/Switches:

Pressure sensing elements shall be corrosion resistant Bourdon tubes, bellows diaphragm or piezoelectric type and shall have the following features:

Adjustable high and low limits.

Suitability for operation in an ambient temperature range of 30-140 degrees F.

Accuracy within 5 percent of full scale.

Pressure and differential pressure switch type units shall consist of a SPDT switch with adjustable setpoint high/low settings. Switches shall be snap action type contacts designed for the application. For switches serving as binary input to the DDC system, contacts shall be short radius gold or rhodium plated. For switches serving as an element of interlock wiring circuits, contacts shall be rated suitable for the load. Switch type units shall operate automatically and, unless indicated to have manual reset, reset automatically when conditions return to normal.

Pressure and differential pressure sensors:

Air differential pressure sensors shall be rated for up to 12" WG high pressure; direct acting linear output 4 to 20 mA.

Water differential pressure sensors shall have a stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; direct acting linear output 4 to 20 mA.

Fan Inlet Airflow Measuring Station:

Provide airflow monitoring device within the inlet cone of centrifugal fans or inlet bell of tubeaxial/vaneaxial fans where indicated on the Drawings. Air monitoring device shall be pitot tube type or thermal dispersion type, as follows:

Pitot tube type shall consist of an array of total and static pressure flow sensors constructed of aluminum or copper and mounted at opposing 90-degree positions around the fan inlet. Flow sensors shall be manifolded together to produce measured velocity pressure that is converted to airflow (cfm) within accuracy range specified herein below. The measured velocity pressure shall be converted to airflow (cfm) with accuracy within ± 2% of the full scale throughout the velocity range from 200 to 4000 fpm.

Thermal dispersion type shall utilize precision thermistors to arranged to measure airflow rate and temperature at multiple sensing locations and relate the thermal transfer rate of a heated element to total airflow rate (cfm). Ensure senor accuracy within ± 2% of reading shall be obtained through individual sensor characterization over a range of 0 to 5,000 FPM in wind tunnels calibrated to volumetric airflow standards. Sensor shall include a flow integration filter.

Air monitoring station shall not obstruct the fan inlet nor have any effect on fan air performance or sound power levels.

Condensate Level Sensor: For each FCU/AHU, provide a plenum-rated water level detection device, conforming to UL 508, consisting of one or more moisture sensors and a N.O. dry contact to serve as a binary input point connected to the building control system to disable mechanical cooling and initiate an alarm in the event the condensate drain is blocked. Device shall include adjustable 1-3 minute time delay before opening to reduce short term nuisance shutdowns. Device shall be mounted on the FCU/AHU, with remote sensor(s) installed in the equipment's factory-installed primary drain pan, located at a point higher than the pan's primary drain line connection and below the overflow rim of the pan. Sensor(s) shall be retained by clips and/or adhesive tape.

Exceptions:

Where the primary drain pan is too shallow or otherwise designed so that sensor(s) cannot be located as required, a drain pan overflow sensor, installed in the pan's secondary drain line connection, may be used.

SPECIAL CONTROLLERS

Fume Hood Exhaust Airflow Controller: Airflow through open face of the hood, regardless of sash position, shall be controlled at a face velocity between 100 fpm and 120 fpm. A velocity sensor-controller located in a sampling tube in the side wall of the hood shall control a damper in the hood discharge to maintain the face velocity. Controller shall incorporate both local visual and audible local alarm and a dry contract alarm output for connection to the facility direct digital control system.

Room Differential Pressure Sensor-Controller: A sensor-controller shall measure the velocity of air flowing into or out of the room through a sampling tube installed in the wall separating the room from the adjacent space, utilizing hotwire anemometer technology, and display differential pressure value on a monitor located adjacent to the room entrance. The sensor-controller shall comply with the following requirements

Operating range: -0.25 to +0.25 inches of water column

Resolution: 5 percent of reading

Accuracy: +/- 10 percent of reading +/- 0.005 inches of water column

Analog output: 0-10 VDC or 4-20 ma signal for interface to facility DDC system for remote differential pressure output for monitoring and alarm. The transmitter module shall be provided with communications interface with DDC system utilizing communications protocol specified in Section 230923. High and low alarm setpoints, and configuration information the sensor-controller shall be user-definable via the DDC system.

ELECTRIC CONTROLS ELEMENTS

Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.

Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.

Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
Selector Switch: Integral, manual on-off-auto.

Hydronic Surface-Mounted Thermostat ("Aquastat"): Snap-acting, single-pole, single-throw, auto-reset switch that opens if temperature rises above adjustable high temperature setpoint or falls below adjustable low temperature setpoint, as indicated by the application.

Electric, Low-Limit Duct Thermostat ("Freezestat): Snap-acting, single-pole, single-throw, manual-reset switch that opens if temperature sensed across any 12 inches of bulb length is equal to or below setpoint of 40°F.

Bulb Length: Minimum 20 feet.
Quantity: One thermostat for every 20 sq. ft. of coil surface. Where multiple low-limit thermostats are required, they shall be wired in series so that any one thermostat will result in the system shutdown as indicated on the Drawings.

FINAL CONTROL ELEMENTS AND OPERATORS:

Control Dampers: Provide dampers with parallel blades for 2- position control, opposed blades for modulating control. Dampers shall be in accordance with Section 233300.

Control Valves:

Valve bodies shall be designed for not be less than 125 psig working pressure or 150% of the operating pressure, whichever is greater. Class 125 bronze body valves and Class 150 stainless steel valves shall comply with ASTM B16.5. Cast iron components shall meet the requirements of ASTM A126, Class B.

Select and size control valves as hereinafter specified and submit complete valve selection list with shop drawings.

Hydronic Control Valves:

General:

Control valve body, packing, and trim shall be designed to withstand the system static head plus the greater of 150% of the maximum pump head or the pump cut-off head at the maximum temperature and velocity of the controlled medium and have no stem lift and leak-by at close-off.

All valves 1-1/2" NPS and smaller shall be brass or bronze bodied with Type 316 stainless steel internal trim (including seats, seat rings, and valve stems). Non-metallic parts of valves shall be designed for 250-degree F operating temperature. Valves shall be packless construction or equipped with pressure sealed molded packing and backseating ring. Dual temperature valves shall be specifically designed for the service.

Pressure *independent* valves 2" NPS and larger shall have flanged cast iron or steel bodies with Type 316 stainless steel internal trim (including seats, seat rings, and valve stems). Non-metallic parts of valves shall be designed for 250-degree F operating temperature. Valves shall be packless construction or equipped with pressure sealed molded packing and backseating ring. Dual temperature valves shall be specifically designed for the service.

Three-Way Modulating Control Valves:

Valves shall be of the modulating globe or ball type and have *linear* position vs. flow characteristic; total flow through the valve shall remain constant regardless of the valve stem position.

Valve rangeability shall be at least 50:1.

Two-Way Pressure Independent Modulating Control Valves:

Valves shall consist of flow regulating balancing valve, modulating temperature control valve, and differential pressure control device within a single valve assembly that shall have *equal percentage* position vs. flow characteristic.

Valves shall maintain flow rate dictated by the input control signal over the full flow range of 0-100% to maintain flow within ±5 % accuracy, automatically compensating for system pressure changes from 5 psig up to at least 50 psig.

Control Valve Sizing:

Two-position control: Valves shall be line size. Select valve for minimum wide open pressure drop.

Modulating 3-Way Control: Minimum valve pressure drop at full flow shall be the greater of 10 feet of water [4 psig] or the pressure drop through the heat exchanger.

Modulating 2-Way Control: Valves shall be sized to operate at no less than 70% available stroke at maximum flow rate. Select control valve C_v to provide control valve authority of at least 0.3 when authority is defined as the pressure drop through the valve at full flow divided by flow through the valve at minimum (0 gpm) flow. Minimum valve pressure drop at full flow shall be the greater of 10 feet of water [4 psig] or the pressure drop through the heat exchanger and piping (including valves, specialties, etc.) serving it.

Damper and Valve Operator/Actuators: Unless indicated otherwise on the Drawings, all actuators shall have fail-safe operation via a mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.

Actuators for Pressure Independent Control Valves: Actuators shall be electronic type furnished and mounted by the control valve manufacturer. Actuators shall accept 2-10 VDC or 4-20 mA input signal from the facility direct digital control system. Actuators shall be electronically programmed by use of external computer software provided by the valve manufacturer for adjustment of flow settings.

Types of Operators/Actuators: Valve operators shall be electronic. Damper operators shall be electronic. Electronic Damper and Valve Operator/Actuator: Shall be direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

For valves, size actuator for torque required for valve tight close at pressure hereinbefore specified.

For dampers, size actuator for running torque calculated as follows:

Parallel-Blade Dampers: 7 inch-lb/sq. ft. of damper.

Opposed-Blade Dampers: 5 inch-lb/sq. ft. of damper.

Dampers with Face Velocities exceeding 1000 fpm: Increase running torque by 2.0.

Couplings shall be V-bolt and V-shaped, with toothed cradle.
Provide electronic overload or digital rotation-sensing circuitry.
Actuator shall operate with proportional input signal of 2-10 VDC or 4 to 20 Ma.

Rated temperature operating range for actuators shall be -20 deg F to +120 deg F for conventional applications and -20 to +250 deg F for smoke or fire/smoke damper application.

Actuator full stroke time requirement shall not exceed 12 seconds to open or 5 seconds to close when applied to control smoke dampers or cooling tower bypass valves.

Electric Two-Position Damper Operator/Actuator: Provide a bi-directional, 120-VAC operator with spring return, size actuator for running torque calculated as follows:

Parallel-Blade Dampers: 7 inch-lb/sq. ft. of damper.

Opposed-Blade Dampers: 5 inch-lb/sq. ft. of damper.

Dampers with Face Velocities exceeding 1000 fpm: Increase running torque by 2.0.

Position Indicator: Actuators shall be provided with a compact, adjustable visual position indicator attached to the actuator. As a damper or valve is cycled, the position indicator shall rotate, causing a cylinder to rotate inside a second cylinder with "display windows." When the damper or valve is open, the word "OPEN" shall be displayed in the two windows located 180° apart. When the damper or valve is closed, the word "CLOSED" shall be displayed. Between the two extremes, the display shall be scaled in degrees (0-90).

PART 3 - EXECUTION

INSTALLATION

Sensors and Controls:

Permanently mark terminal blocks for identification. Protect all circuits to avoid interruption of service due to short-circuiting or other conditions. Line-protect all wiring that comes from external sources to the site from lightning and static electricity.

Label or code each field wire at each end. Permanently label or code each point of all field terminal strips to show the instrument or item served. Color-coded cable with cable diagrams may be used to accomplish cable identification.

Temperature Sensors:

Install all sensors and instrumentation according to manufacturer's written instructions. Temperature sensor locations shall be readily accessible, permitting quick replacement and servicing of them without special skills and tools.

Low-limit thermostats ("freezestats") shall be located at an elevation at or above the top of the coil being protected and the capillary element installed in a serpentine arrangement across the face of the coil starting at the top and ending at the bottom.
Mount sensors rigidly and adequately for the environment within which the sensor operates.

Sensors used in mixing plenum shall be of the averaging of type. Averaging sensors shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip.

Pipe-mounted temperature sensors shall be installed in wells completely filled with thermal conducting material.

All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor reading.

Duct Pressure/Airflow Sensors/Switches:

Sensors shall be connected to pressure or airflow monitoring stations.

Duct, Plenum, and Outdoor Air Intake Airflow Monitoring Stations.

Each airflow measuring station shall be installed as located and detailed on the Drawings in accordance with the manufacturer's minimum installation conditions for the indicated application and shall not amplify the sound level.

Differential Pressure Sensors/Switches:

Mount pressure sensor a minimum of 5 pipe diameters upstream and 5 pipe diameters downstream or 2 feet, whichever is greater, from fittings and other obstructions.

Actuators:

Mount damper and valve actuators according to manufacturer's written instructions.

Damper actuators shall be located outside of the airstream.

Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed position.

Check operation of valve/actuator combination to confirm that actuator modulates valve smoothly in both open and closed position.

FIELD TEST AND INSPECTIONS

Upon completion of installation of each sensor or final control element, field inspect and mechanically and electrically test for proper function.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 230913

SECTION 230923 – EXTENSION OF EXISTING DIRECT DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to the work of this section.

Section 230913, which specifies the requirements for sensors, devices, actuators, and final control elements utilized by the DDC system.

Section 230924, which specifies the requirements for original equipment manufacturer (OEM) controllers/ gateways provided under Division 23.

QUALITY ASSURANCE

Single Source Responsibility of Supplier: The controls system sub-contractor shall be responsible for the complete installation and proper operation of the control system. The sub-contractor shall be in the regular and customary business of design, installation and service of computer-based building environmental control systems similar in size and complexity to the system specified. The sub-contractor shall be the manufacturer of the primary DDC system components or shall have been the authorized representative for the primary DDC components manufacturer for at least 5 years. The sub-contractor must be licensed as an “unlimited electrical contractor” in the state in which the Project is constructed, shall have a factory-certified trainer on staff, and provide 5 day per week local technical support. **Submit documentation of these sub-contractor qualifications to the A-E for review.**

Equipment and Materials: Equipment and materials shall be cataloged products of manufacturers regularly engaged in production and installation of HVAC control systems. Products shall be manufacturer's latest standard design and have been tested and proven in actual use.

Commissioning of HVAC systems requires participation by the direct digital controls subcontractor as a member of the "Commissioning Team". See Section 230510 and Division 1 for requirements.

GUARANTEE PERIOD SERVICES

Maintenance of Control Hardware: The Contractor shall inspect, repair, replace, adjust, and calibrate, as required, the file server/workstation(s), associated peripheral equipment, and control units. The Contractor shall then furnish a report describing the status of the equipment, problem areas (if any) noticed during service work, and description of the corrective actions taken. The report shall clearly certify that all software is functioning correctly.

Maintenance of Control Software: The Contractor shall maintain all software. In addition, all factory or sub-vendor upgrades to software shall be added to the systems, when they become available, at no additional cost to the Owner.

Service Period: Routine system service shall be provided on a monthly basis for the first six (6) months of the guarantee period and at least every three months during the second six (6) months. Calls for service by the Owner shall be honored within 24 hours and are not to be considered as part of routine maintenance.

Service Documentation: A copy of the service report associated with each routine service visit or Owner-initiated service call shall be provided to the Owner and the A-E with 10 days after the date of each service call.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, model number, and other relevant technical data. Include technical data for operator workstation equipment, interface equipment, control units, communicating thermostats, transducers/ transmitters, sensors, actuators, valves, relays/switches, control panels, operator interface equipment, etc..

DDC System Software:

Include technical data for operating system software, operator interface, color graphics, and other third-party applications.

List of graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.

Controlled Systems:

Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

Bill of materials of equipment indicating quantity, manufacturer, and model number for each controlled system

Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring and termination labels.

Details of control panel faces, including controls, instruments, and labeling.

Written sequences of operation. The sequence shall include reference to schematic diagram(s) that is/are applicable. Include "on/off" and "occupied/unoccupied" schedules, as applicable for each controlled system.

Schedule of software interlocks between HVAC equipment or components. Include any "groupings" of controlled systems that may be used to initiate on/off control of any other controlled system.

Schedule of dampers including size, leakage, and flow characteristics.

Schedule of valves including flow characteristics.

DDC System Hardware:

Wiring diagrams for control units and communicating thermostats, with termination numbers.

Schematic diagrams and floor plans for field sensors and control hardware.

Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.

Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.

Graphic Displays: Include color prints or "screen shots" of each proposed graphic display proposed, complete with clear indication of (1) static components and dynamic components and (2) "on"/"off"/"alarm" condition designation convention.

Samples for Initial Selection: For each color available for each type of thermostat, sensor, etc. cover exposed to view with factory-applied color finishes.

Data Communications Protocol Certificates:

For extension of an existing DDC system that utilizes the BACnet communications protocol, certify that each proposed DDC system component complies with ASHRAE Standard 135-2012 **and is BACnet Laboratory tested and certified**.

For extension of an existing DDC system that utilizes LonWorks technology using CEA-709.1-C as the communications protocol, each proposed DDC system component shall be certified by LonMark International.

Closeout Submittals:

Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.

Interconnection wiring diagrams with identified and numbered system components and devices.

Keyboard illustrations and step-by-step procedures indexed for each operator function.
Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

Calibration records and list of set points.

Software and Firmware Operational Documentation: Include the following:

Software operating and upgrade manuals.

Program Software Backup: On a magnetic media or compact disc, complete with data files.

Device address list.

Printout of software application and graphic screens.

Software license required by and installed for DDC workstations and control systems.

PART 2 - PRODUCTS

SYSTEM DESCRIPTION

Provide extension to the Owner’s existing direct digital control system utilizing the Owner's network system consisting of existing server, LAN/WAN, and server-resident network software.

Existing control system for the building is Trane Tracer.

Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on a token-passing network and programmed to control mechanical systems.

JOB CONDITIONS (ENVIRONMENTAL CONDITIONS OF OPERATION)

LAN hardware shall be designed to operate in ambient conditions of 65 to 90 degrees F at a relative humidity of 20 to 80 percent, non-condensing.

Digital control equipment shall comply with the following:

Digital control equipment shall be designed to operate in ambient conditions of 35 to 120 degrees F at a relative humidity of 0 to 95 percent non-condensing.

Control units as hereinafter specified shall operate properly with power fluctuations of plus 15 percent to minus 10 percent of nominal supply voltage.

Electric and electronic equipment shall be properly mounted and organized in a grounded and Listed NEMA 1 cabinet (panel). Cabinets or enclosures shall protect equipment from dust, liquids or accidental blows.

NETWORK COMPONENTS

Network Software: Software shall be upgraded as necessary to include the following capabilities:

I/O capability from any network operator workstation or through a browser. The system operator interface shall be an easy to use, self-guiding, menu-penetration, windowing approach. Key features that shall be included in the interface are as follows:

Object/point descriptions used for applications such as graphics, reports, alarms, etc. shall be same as the object/point name as specified above.

Engineering units shall be the English ("inch-pound") system.

Interactive operation and help messages.

Organization of points into logical groups or “systems” and an information penetration scheme that provides quick and simple method for maintenance staff to determine HVAC conditions and problems at any school, as follows:

Initial facility information display will be one or more graphic "floor plans" that include basic site information and specific room by room data. Each of these data points are displayed as "hot buttons" so that selecting any data display takes the user to next, more detailed information level. The floor plan display(s) shall provide display of room numbers, along with temperature, humidity, CO_2, occupancy, etc. conditions in each space. Designation of the HVAC terminal unit, air unit, and/or system serving each space shall also displayed and selecting that hot button shall take the operator to the detailed system points display for that terminal unit, air unit, and/or system serving the room.

At the HVAC system, subsystem, or component level, a graphical display or "tree structure" structure display may utilized, as selected by the user.

Site information shall include direct hot button links to primary heating and cooling systems. (For example, selecting "CHWSTemp" shall take the operator immediately to the graphic or tree structure display of the facility chilled water cooling system, while selecting "HWSTemp" shall lead to the facility hot water heating system.)

Pictorial representation of data on color graphic terminals with dynamic data.

Capability to alternate between graphic and text displays for the same logical group.

Automatic system diagnostics; monitor system and report failures of both controlled equipment and control system components.

Database creation and support.

Automatic and manual database save and restore.

Dynamic color graphic displays with multiple screen displays at once.

Custom graphics generation and graphics library of HVAC equipment and symbols.

Alarm and event processing.

Provide audible and visual means of alarm indication. The alarm dialog box shall always become the top dialog box upon receipt of an alarm irrespective of the foreground application. Alarms assigned for printout shall be routed to the destination printer. In addition, alarms shall be capable of being routed to specified personnel by means of pager or mobile telephone.

User-defined alarm messages shall be generated and delivered in conjunction with the alarm notification.

Alarms shall be routed to the appropriate destination device(s), based on time and other conditions. An alarm shall be able to initiate sequences, print, be logged in the event log, generate custom messages, and automatically display an associated system graphic.

Any object in the system shall be configurable to generate alarms on transition in and out of normal state. The operator shall be able to configure the alarm category, alarm limits, alarm limit differentials, states, al arm message, states and reporting actions for each alarm in the system.

Minimum alarm categories required are notification, maintenance, critical and security.

Automatic restart of field equipment on restoration of power.

Data collection, reports, and logs. Include standard reports for the following:

Current values of all objects.

Current alarm summary.

Disabled objects.

Alarm lockout objects.

Logs:

Retrieve and display default logs, including "all points log", "system points log", "alarm log", etc.

Create, retrieve, and display trend logs, in real time, of historical object data stored in remote CUs.

Maintain trend log files saved to hard disk for subsequent use in spreadsheet or database programs.

Dynamically graph the trend logged object data by creating two-axis (x, y) graphs that simultaneously display values relative to time for up to eight objects in different colors.

It shall be possible to trend log any number of points at least equal to twice the number of connected physical points. Any object in the system (physical or calculated) may be logged.

Once established, trend logs shall continue until deleted by user. Data storage sufficient for at least 30 days shall be provided for each trend log.

Custom report development.

Utility and weather reports.

Application editors for controllers and schedules.

DIRECT DIGITAL CONTROL UNITS

General: Multiple digital control units (CUs) shall be provided. ***CUs shall be fully field programmable and the use of firmware-based application specific controllers is prohibited.*** All control functions shall be resident in the CUs, including those involved in building-wide strategies.

Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.

Control units shall fully comply with the system architecture and communication requirements specified hereinbefore.

Units shall monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.

Stand-alone mode control functions shall operate regardless of network status. Functions include the following:

Global communications.

Discrete/digital, analog, and pulse I/O.

Monitoring, controlling, or addressing data points.

Software applications, scheduling, and alarm processing.

Testing and developing control algorithms without disrupting field hardware and controlled environment.

Provide local operator interface to provide for download from or upload to operator workstation or diagnostic terminal unit.

Standard Application Programs:

Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, anti-short cycling, P/PI/PID control as hereinafter, DDC with fine tuning, and trend logging.

HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.

Chiller Control Programs: Control function of condenser-water reset, chilled-water reset, and equipment sequencing.

Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access. Remote communications.

Maintenance management.

Units of Measure: Inch-pound.

Local operator interface to provide for download from or upload to operator workstation or diagnostic terminal unit.

Control Modes: Control loops shall be able to utilize any of the following control modes:

Two position (e.g., on-off, slow-fast)

Proportional (P), proportional plus integral (PI), or roportional plus integral plus derivative (PID), applied as follows:

Controlled Variable	Control Mode
Space Temperature	P
Mixed Air Temperature	PI
Coil Discharge Temperature	PI (cooling), P (heating)
Hot Water Supply Temperature	P
Airflow	PI (with wide proportional band and fast reset rate) or PID
Fan Static Pressure	PI
Humidity	P (PI throttling range is less than 5%)
Dewpoint Temperature	P (PI throttling range is less than 2 F)

For any unlisted application, the control mode shall be as approved by the A-E.

I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

Digital (Binary) Inputs: Allow monitoring of on-off signals without external power.

Pulse Accumulation Inputs: Accept up to 10 pulses per second.

Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.

Digital (Binary) Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.

Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.

Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.

Universal I/Os: Provide software selectable binary or analog outputs.

Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

Output ripple of 5.0 mV maximum peak to peak.

Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.

Built-in over-voltage and over-current protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:

Minimum dielectric strength of 1000 V.

Maximum response time of 10 nanoseconds.

Minimum transverse-mode noise attenuation of 65 dB.

Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

Diagnostic Devices: Each CU shall be supplied with connections to which Owner's maintenance personnel can connect portable diagnostic operator's terminals (PDOTs) for data display, setpoint modification, and reloading and modification of controller programs.

Spare Equipment: Provide spare control unit boards and spare I/O boards as required. It shall be possible for trained Owner personnel to replace CU boards and load software via a workstation or PDOT:

Provide two spare control unit boards. If power supplies are separate, supply separate power supplies and other parts to make at least two complete sets of DDC control equipment spares.

If I/O boards are separate from the CU boards, provide four spare I/O boards for each spare CU board provided above.

Control Functions: All control functions shall execute within the standalone control units via DDC algorithms. The operator shall be able to customize control strategies and sequences of operations defining the appropriate control loop algorithms and choosing the optimum loop parameters. Each CU shall include the following standalone functions:

Direct Digital Control algorithms and control sequences are to be CU resident and be capable of standalone operation. All DDC programs shall be custom written as required to meet the performance criteria spelled out in the sequence of operation paragraphs for each controlled mechanical system. PID control mode shall be employed as appropriate to the application and per sequences or operation.

Enable/Disable: All CU resident DDC programs shall be capable of being enabled or disabled from any workstation. In the enable mode all DDC loops shall be active and output signals shall be routed to the final control elements. In the disable mode all DDC loop calculations shall continue but outputs to actuators shall be suppressed. (When disabled, control outputs shall stay in the same state or position as commanded from the central or until they are manually set to automatic.)

Integral Windup Prevention: To eliminate integral windup, all PID programs shall automatically invoke integral windup prevention routines whenever the controlled unit is off, under manual control or under control of an system or time initiated program, or when the controlled unit is in the process or starting or stopping.

Default Value Operation: All CUs shall be capable of being programmed to utilize stored default values for assured fail-safe operation of critical processes. Default values shall be invoked upon sensor failure or, if the primary value is normally provided by the central or another CU, by loss of bus communication. Individual application software packages shall be structured to assume a fail-safe condition upon loss of input sensors. Loss of an input sensor shall result in output of a sensor-failed message at the central control and command station. Each CU shall have capability for local readouts of all functions.

APPLICATION SOFTWARE

Provide the following programs in addition to control algorithms defined on the drawings:

Scheduling: Provide a calendar format for annual time-of-day scheduling for equipment operation, trending, logging and reports, etc. Provide the following minimum features:

Day-type schedules (Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday, Holiday, Pre-Holiday day, Vacation day, Special Day, etc., 24 hours per day)

Monthly schedules (allow individual assignment of day types to each day of the month).

Yearly schedules (allow schedules to be applied on an annual basis and be edited and re-applied to a following year).

Provide user-defined "on-off" schedules as specified assignable to an individual HVAC system, subsystem, and/or component. This schedule shall dictate the starting and stopping times, on a daily basis, of the designated systems and components.

Provide user-defined "occupied-unoccupied" schedules as specified above for operation of each fan coil unit, blower coil unit, air-handling unit, ventilation air system, etc. This schedule shall dictate the opening and closing of ventilation air dampers, the starting and stopping of exhaust fans associated with each unit, the operation of make-up air units, etc., on a daily basis, so that ventilation air is provided only during the specific periods during which the area served is occupied.

Temporary override of above schedules shall be allowed by operators with access levels as specified above. A temporary override shall (1) extend hours of use of HVAC systems, subsystems, and/or components up to midnight on weekdays and (2) allow use of HVAC systems, subsystems, and/or components during scheduled "off" periods for a maximum of 12 hours. When an override use period terminates, the temporary override time(s) shall be voided and affected HVAC elements shall return to their normal schedules.

When multiple motors associated with an HVAC are commanded "on" at the same time, the individual DDC start commands shall be staggered by 5 second intervals to second intervals to minimize inrush current.

Optimum On/Off: Program shall consider both outdoor weather conditions and indoor thermal zone conditions to perform the following functions to minimize the operation of space cooling and heating systems:

Start HVAC equipment at the latest possible time after its scheduled “on” time in order to achieve the desired zone comfort condition in the coolest or warmest zone by its “occupied” time.

Stop HVAC equipment at the earliest possible time after its “unoccupied” time and before its scheduled “off” time and still maintain desired zone comfort condition in the coolest or warmest zone.

Coordinate automatically with on/off schedules assigned by the user.

Event Initiated Programs (EIPs): Event initiators may be any digital data point in the system, real time values, or any analog alarm limit. The EIPs shall be structured so that one initiator may set and reset the EIP as it goes from normal to off-normal and back to normal, or one initiator may set the program and a second initiator reset the program, or reset may be manual via the console keyboard. Setting an EIP shall cause a series of start or stop commands to assigned loads to be executed to EIP's points. EIP's shall have priority assignments to allow them to override other programs in the set mode when desired. The operator's terminal shall have read-write capability for initiator load and priority assignment.

Alarm Initiation and Response:

All AI points shall have user-defined upper and/or lower condition limits. If user-defined limits are not defined, ***default limits shall be initially set as follows***:

Space temperature	5ºF below low setpoint of comfort zone or 5ºF above high setpoint of comfort zone
Space humidity	≥5% RH above setpoint
AHU mixed air low limit	≤38ºF
Cooling coil leaving air	≥60ºF
Heating coil leaving air	≤90ºF
CHW supply	≥48ºF
HW supply	≤120ºF

Monitor and display "status" (on/off, high/low, open/closed, etc.) of each DI point. Motor on/off status shall be indicated by current sensing relays with field-adjustable trigger point to provide DI "switch", as hereinafter specified.

Monitor and display condition of each AO point (valve or damper percent open, motor speed percent of full speed, etc.)

An alarm shall be initiated whenever any of the following conditions occur:

Any AI point high or low limit alarm setpoint is exceeded.

Any DI status condition does not correspond to the DDC command condition (i.e., damper is closed when occupied/unoccupied schedule requires damper to be open, motor is operated in "hand" rather than "auto" mode, etc.)

Any AI or DI device fails or goes "out of range".

Any AO device fails to respond to DDC command condition.

If any AO control loop continues to cycle its output more than 40% of its range (user adjustable) 3 or more times in any 60 minute internal.

For variable air volume AHUs, if any supply fan or return/relief fan speed AO output signal remains above 95% for more than 8 hours (user adjustable) accumulated per "on" period for 3 or more consecutive "on" periods.

If any AHU coil control valve(s) AO output signal remains above 95% for more than accumulated 8 hours (user adjustable) per "on" period for 3 or more consecutive "on" periods.

If any humidifier valve AO output signal remains above 85% for more than accumulated 8 hours (user adjustable) per "on" period for 3 or more consecutive "on" periods.

During "on" periods, if any cooling coil chilled water return temperature is greater than design for more than 4 hours during which coil chilled water supply temperature was at or below design setpoint temperature.

Automatic Restart Programming:

When a power failure is detected in any phase, the DDC system shall command all electrical equipment served by the failed power source "off".

If the associated CU is powered by normal or emergency power, it may monitor its own power source as an indication of power status.

If the CU is powered by uninterruptible power supply (UPS), or if it is not capable of monitoring its own power for use in sequences, Contractor shall provide at least one voltage transformer (three phase when applicable) for each facility for the DDC system to monitor for power status.

When the DDC system detects normal or emergency power has been restored to the failed power source, all equipment served by that source that was commanded "off" shall be automatically restarted. Restart shall be sequenced by the CU network restart program with a 5 second interval between starts to minimize inrush current.

Preventive Maintenance Instruction (PMI) programming: A preventive maintenance alarm shall be triggered indicating maintenance requirements based on run time. The log shall include all equipment listed in the runtime schedule data base that have reached limit criteria of calendar-date (month-day-year) or high accumulation of totalized run-time (for points with start/stop or run status indication). Each message shall include point descriptions, limit criteria and preventive maintenance instruction assigned to that limit. Message shall be provided for each component of units such as air handling units. All limit criteria, PMI and reset-to-zero assignments shall be operator programmable, on-line at the keyboard. Stagger initial alarms to distribute maintenance throughout the year.

Program initial PM alarms as follows:

Fans and pumps, run time 4000 hours

All other, calendar time 4 months

Air Flow and Pressure Control:

Air flow and static pressure shall be controlled via direct digital CUs with inputs from air flow control measuring stations and static pressure inputs as specified in Section 230913 and indicated on the Drawings. Controller outputs shall be true analog output signals. Pulse width modulation outputs are not acceptable. The airflow control programs shall be standard factory tested programs that are documented in the literature of the control manufacturer.

Duct Static Pressure Control: Systems shall consist of one or more static pressure sensors as specified in Section 230913 and indicated on the Drawings, along with relays or auxiliary devices as required to produce a complete functional system. The span of the transmitter shall not exceed two times the design static pressure at the point of measurement. The output of the transmitter shall be true representation of the input pressure with plus or minus 0.1-inch wg of the true input pressure.

For systems with multiple major “trunk” supply ducts, provide a static pressure transmitter for each trunk duct. The transmitter signal representing the lowest static pressure shall be selected as the input signal to the CU.

The CU shall receive the static pressure transmitter signal and shall provide a control output signal to the supply fan capacity control device using control modes hereinbefore specified.

Constant Volume Control: Systems shall consist of a static/total pressure sensor as specified in Section 230913 and a differential pressure transmitter, along with such relays and auxiliary devices as required to produce a complete functional system. The transmitter shall receive its primary total pressure and static pressure signal from the flow measuring station and shall have a span not exceeding three times this differential pressure at the design flow rate. The CU shall receive the transmitter signal and shall provide an output to the fan volume control device to maintain a constant flow rate. Overall system accuracy shall be plus or minus 0.008-inch velocity pressure as measured by the flow station.

Ventilation Air Flow Control for VAV Systems: The airflow rate of return or exhaust fan(s) of variable air volume systems shall be controlled in response to the supply airflow rate, resulting a constant ventilation airflow rate and a positive building pressure. An airflow monitoring station, as specified in Section 230913 and as indicated on the Drawings, shall be utilized to determine the flow rates at each fan.

Additional application control requirements shall be met as required by the DDC control logic diagrams on the Drawings.

CABLING AND WIRING

DDC Cabling: Cabling between buildings shall be fiber optic. **Network cabling within buildings shall be shielded twisted pair or fiber optic**. Cabling or wiring between control units and I/O point devices shall be as follows:

Application	Cable/Wire Type and Min. Gauge (AWG)
Digital Input Wiring	24 gauge, twisted pair
Analog Input Wiring	24 gauge, shielded twisted pair
Digital Output Wiring	24 gauge stranded for 24V 18 gauge stranded for 120V
Analog Output Wiring	24 gauge, twisted pair

Data Cable:

Twisted shielded cables shall have FFEP insulation in thermoplastic jacket, with #24 AWG stranded conductors, minimum. Shield shall be tinned, soft-copper strands formed into a braid or equivalent foil. Shielding coverage on conductors shall not be less than 100 percent.

Multimode fiber optic cables shall be 62.5/125 micron Class Ia Graded Index Multimode Optical Fiber**,** OFNR, OFNP, Outdoor or Indoor / Outdoor (I/O) NEC Rating, FDDI Compliant.

Coating Diameter: 250 Microns

Core Eccentricity: 7.5% maximum (1.5% typical)

Numerical aperture: .275 plus or minus .015

Attenuation: 3.5 dB/km @ 850 NM / 1.50 dB/km @ 1300 NM

Bandwidth: 160 MHz at 850 NM / 500 MHz @ 1300 NM

Fiber connectors: ST .75 dB maximum insertion loss

Cable bend radius: 10 times diameter

Single mode fiber optic cables shall be 8.3/125 micron Class IVa Dispersion-Unshifted Single-mode Optical Fiber, OFNR, OFNP, Outdoor or Indoor / Outdoor (I/O) NEC Rating, FDDI Compliant.

Coating Diameter: 250 Microns

Core Eccentricity: 7.5% maximum
(1.5% typical)

Attenuation: 0.5 dB/km @ 1310 NM/1550 NM

Zero dispersion wavelength 1300 -1320 NM

Cable bend radius: 10 times diameter

Control and Interlock Wiring: All 24V-120V control and interlock wiring shall comply with Section 230511 and the following:

Conductors:

All wire and conducting components shall be THWN standed copper.

Conductors shall be continuous from device to device and no splices shall be made except within device or junction boxes. ***Wire nuts and crimp slices are prohibited.***

Control wiring shall be color-coded in accordance with reviewed submittals.

Where conductors pass through a junction box or connect to a device, the conductor and the box shall be tagged to indicate the circuit and/or terminal number shown on the submittal drawings.

Raceway: Provide electrical metallic tubing (EMT), minimum 3/4" size. Fittings shall be steel insulated throat compression type. ***Set screw fittings, fittings constructed of alloys of aluminum or fittings of the indenter type are prohibited.*** Flexible metallic raceway may be utilized for the last 24" up to the connection point for devices, sensors, etc.

Routing of Raceway: Exposed raceway shall line up work true to adjacent surfaces and be placed in a workmanlike manner. Raceway shall be run at right angles to building lines; this requirement does not apply to raceway located below concrete placed as a part of this project. Raceway shall be sturdily supported and separated in a manner satisfactory to the A/E; raceway shall not be supported by the ceiling grid or ceiling grid support wires. In general, all raceway is to be concealed and routed overhead, below the floor, or in walls except in electrical or mechanical equipment rooms. Raceway in such rooms may be surface mounted.

Device Boxes: Device boxes for use in sheetrock or paneled surfaces shall be of galvanized steel, 4 inches square of a depth necessary to contain the intended device(s) and associated conductors. Boxes shall be sized to have no less than the minimum volume as required by the NEC. Boxes must be flush mounted and accommodate device(s) and all wires and connections without crowding. Boxes shall be furnished with a suitable plaster ring of the depth required to match the wall (or ceiling) material. Where the surface material or covering is combustible the front edge of the plaster ring shall be absolutely flush with the surface. Where the wall material is non-combustible, the front of the plaster must be recessed into the wall no further than 3/16 inch. Device boxes for flush mounted use in masonry walls shall be of the concrete tight masonry type sized for the number of device(s) and conductors. In locations where surface mounting of device boxes is permitted on masonry walls, provide 1/2 inch raised cover and suitable plaster ring.

Junction Boxes: Junction boxes shall be of galvanized steel of size, type, and shape for intended use and having adequate volume as required by NEC. All junction boxes shall be concealed unless specifically permitted elsewhere in these Specifications or on the Drawings. Boxes must be supported from the building structure without dependence on support of conduit, fixture support wires, ceiling support wires, or similar items.

Device and/or Junction Box Wall Penetrations: All wall penetrations at device or equipment locations must be protected in such a manner that the fire rating of the wall is maintained. ***It is the responsibility of the Contractor to assure that fire and smoke integrity of all walls is maintained at all penetration points***.

PART 3 – EXECUTION

INTERFACE WITH OEM CONTROLLERS/GATEWAYS

The OEM is responsible for coordination between the DDC system sub-contractor and OEM unit controls provided to ensure that required control interface is implemented, resulting in full interoperability between OEM unit controls and the DDC system.

The OEM shall provide a Protocol Implementation Conformance Statement (PICS) that identifies the particular objects and options specified by BACnet or LonMark, as applicable, that are implemented in the OEM controller/gateway. *The controls system sub-contractor shall utilize the information provided by the OEM to correctly interface the DDC system with the OEM controllers/gateways provided and coordinate with the OEM to ensure that the interface provided complies with the information/data provided by the OEM*.

INSTALLATION

Provide skilled technicians, properly trained and qualified for the work and directed by experienced engineers.

Except for short apparatus connections, run raceway and pneumatic tubing parallel to or at right angles to the building structure. Conceal raceway and tubing in finished spaces.

Do not run tubing or raceway concealed under insulation or inside ducts. Mount control devices, tubing and raceway located on ducts or apparatus with external insulation on standoff supports to avoid interference with insulation.

Run tubing and wire connecting devices on or in control cabinets parallel with the sides of the cabinet neatly racked to permit tracing. Rack connections bridging a cabinet door along the hinge side and protect from damage. Provide grommets, sleeves or vinyl tape to protect plastic tubing or wires from sharp edges of panels, raceway, and other items.

Cabling and Wiring Installation:

Raceway: All control cabling and interlock wiring shall be installed in raceway.

Exception: Where Class 2 wiring is located in concealed and accessible locations, including supply or return air plenums, plenum-rated cables complying with NFPA 262 may be installed without raceway, provided that:

Circuits meet NFPA 70 Class 2 (current-limited) requirements.

All cables shall be UL-listed for the application.

Do not install Class 2 wiring in raceway containing Class 1 wlring. Boxes and panels containing high voltage (120 V+) may not be used for low voltage wiring except for the purpose of interfacing the two via relays, transformers, etc.

Shielded, twisted pair cable shielding shall be grounded at each connection point.

Fiber Optic Cable:

Route all interior cables in raceway within walls and inaccessible ceiling spaces.

Use nylon bushings at top of conduit where stubbed in accessible ceiling spaces.

Support all cables using J type hooks where open cable is permitted.

Route all fiber optic cable in raceway with innerducts. The innerducts shall contain a pull string, if no fiber is pulled at the time of the installation of the duct.

All conduit where fiber optic cable is installed shall be sized to maintain the manufacturer's recommended bend radius of fiber optic cables. As a minimum, conduit shall be provided with long radius elbows.

All cables shall be terminated using appropriate termination equipment.

Fiber Termination Panels: Provide a rack mountable, modular cabinet capable of terminating up to 24 type ST multimode fiber cables. Panels shall be as manufactured by Ortronics, Amp, Siecor, or Superior.

Fiber Optic Testing

Upon completion of the passive optical cable system, the system must be tested to ensure compliance with the design and link loss specifications. The tests include:

Power Meter Tests: For building risers, power meter tests are required.

End-to-End Attenuation Testing: Tests shall be completed on each fiber span at both operational wavelengths:

850/1310 nm multimode

1550 nm single mode

Testing in one direction is required. Link attenuation does not include any active devices or passive devices other than cable, connectors and splices (e.g., link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers. Test results should be retained for inclusion into the documentation package.

Connector loss readings of each completed connector should be recorded using an OTDR at 850 and 1310 nm in one direction.

Optical time domain reflectometer (OTDR) signature traces of each terminated fiber should be recorded at 850 nm and 1310 nm for fiber continuity purposes. OTDR testing is mandatory for runs longer than 2 km.

Final report shall be compiled which records system configuration, fiber labels, cable routes and "as built" details. Loss measurements with calibrated light source and power meter shall be included. OTDR traces shall also be included when requested in advance.

Smoke detectors and/or fan shutdown relays initiated by a fire alarm system shall be integrated into the control system and sequence of operation as indicated and/or required.

FIELD QUALITY CONTROL

Perform the following field tests and inspections and prepare test reports after completion of DDC system installation:

After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.

Test and adjust controls and safeties.

Test calibration of control units by disconnecting input sensors and stimulating operation with compatible signal generator.

Test each control point through its full operating range to verify that safety and operating control set points are as required.

Test each control loop to verify stable mode of operation and compliance with sequence of operation.

Test each system for compliance with sequence of operation.

Test software and hardware interlocks.

DDC Verification:

Verify that instruments are installed before calibration, testing, and loop or leak checks.

Check instruments for proper location and accessibility.

Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.

Check instrument tubing for proper fittings, slope, material, and support.

Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.

Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.

Check temperature instruments and material and length of sensing elements.

Check control valves. Verify that they are in correct direction.

Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.

Check DDC system as follows:

Verify that DDC controller power supply is from emergency power supply, if applicable.

Verify that wires at control panels are tagged with their service designation and approved tagging system.

Verify that spare I/O capacity has been provided.

Verify that DDC controllers are protected from power supply surges.

Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

CALIBRATION AND ADJUSTMENT

General:

Make three-point calibration test for both linearity and accuracy for each analog instrument.

Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.

Control System Inputs and Outputs:

Check analog inputs at 0, 50, and 100 percent of span.

Check analog outputs using milliampere meter at 0, 50, and 100 percent output.

Check digital inputs using jumper wire.

Check digital outputs using ohmmeter to test for contact making or breaking.

Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

Flow:

Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.

Manually operate flow switches to verify that they make or break contact.

Pressure:

Calibrate pressure transmitters at 0, 50, and 100 percent of span.

Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

Temperature:

Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.

Calibrate temperature switches to make or break contacts.

Stroke of valves and dampers:

Without positioners, follow the manufacturer's recommended procedure, so that valve or damper is 100 percent opened and closed.

With positioners, follow manufacturer's recommended procedure, so that valve and damper is positioned at 0%, 50%, and 100% closed.

Provide diagnostic and test instruments for calibration and adjustment of system.

Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

Adjust initial temperature and humidity set points.

VERIFY SENSOR ACCURACY

Select 100% of installed gas concentration sensors for testing:

Carbon Dioxide (CO_2): Prior to placing the DDC system in operation, sensors shall be tested and recalibrated as needed in accordance with the manufacturer's written procedures. Calibration shall use a minimum of two calibration gas samples, one a 950-1050 ppm and one at either 0 ppm or 450-550 ppm, with the concentration of the calibration gas known within +/- 2%. *Sensors that cannot be calibrated to within +/- 60 ppm of calibration gas CO_2 concentrations at each test point shall be replaced*. The replacement sensor shall then be calibrated. Provide sensor test/calibration reports for review by the A/E.

Select at least 10% of the installed temperature, humidity, pressure, airflow, etc. sensors, including at least one of each sensor type, for testing. If calibration of 10% or more of this sample is found to be incorrect, select an additional 10% of the installed sensors for testing. **If calibration of 10% or more of this second sample is found to be incorrect, test/calibrate all sensors.**

Sensor calibrating instruments shall be used in checkout of the overall performance. The sensors of these instruments shall be placed at the proximity of DDC system sensors to indicate the conditions of the controlled media (air, water, etc.). A preliminary evaluation shall be made as to the suitability of having the DDC system sensors checked in-place or they may be placed in simulated environment. If the response times of the two sensors (DDC system sensor and calibration sensor) are similar, testing may be performed with the sensors in place. If the conditions of the controlled media change slowly, testing may also be performed with the sensors in place. However, if the conditions of the controlled media change rapidly and the time responses of the two sensors vary considerably, testing shall be done with the sensors placed in a known environment such as a temperature bath.

Verification procedures: Verification of sensor accuracy shall be made using the following procedures. Compare readings for each sensor from the calibration instrument and the DDC system to determine if the measurement accuracy meets the requirements of Section 230913.

Temperature: Use a multi-point verification check at various points in the operating range (including minimum, typical, and maximum), utilizing a calibrated thermometer and Dewar flask or a calibrated portable drywell (±0.5ºF) temperature probe calibrator.

Relative Humidity: Use a single point calibrator or portable environmental chamber that has been lab calibrated with a NIST traceable dew point monitor (±3% RH).

Fluid Flow: Use a portable ultrasonic flow meter (UFM) to spot check flows. The meter's flow profile compensation shall be turned off and the acceptable deviation between the measuring flow meter and the UFM be restricted to ±5% for applications with less than 10 pipe diameters of straight length pipe upstream of the UFM. If variable flow conditions exist, both the flow and the flow profile will need to be evaluated at a range of conditions. See ASHRAE Standard 150, Annex D, for a detailed method.
Air Flow: Utilize calibrated pitot tube or propeller anemometer traverses in at least two planes upstream of the air flow monitoring station. For VAV systems, test airflows over a range of at least five flow rates between 20% and 100% of design flow.

Pressure: Use a multi-point verification check at various points in the operating range (including minimum, typical, and maximum) with a calibrated dead weight tester or an electronic pressure calibrator for ranges above atmosphere, or an accurate digital pressure gage for ranges below atmosphere.

Vacuum: Vacuum range pressures can be attained with a vacuum pump, with an atmospheric pressure gage as the reference. Draw a vacuum on the transmitter. Use a 0 to 1000 micron vacuum gage to verify that 0 psia has been reached, if it is one of the calibration-check points. Zero the reference gage if necessary. Gradually bleed air into the system. At each point, stop the bleed and record the data.

Differential pressure: Use a dead weight tester or electronic calibrator or a magnehelic gauge with a pressure bulb to their high-pressure side to apply a known pressure at various points in the operating range (including minimum, typical, and maximum).

Very Low Differential Pressure: Use a micromanometer or digital manometer of narrow range to spot check pressures at various points in the operating range (including minimum, typical, and maximum). The manometer must be zeroed. A hand pump/bleed valve setup can be used to apply the small pressures required to the high sides. The manometer is adjusted and the instrument readings are compared at the high and low point. The temperature of the manometer fluid should be used to adjust its readings to the standard temperature conditions of the transmitter.

VERIFY FINAL CONTROL ELEMENT FUNCTIONALITY

Test each final control element operator to ensure performance in accordance with Section 230913 and the control sequences defined on the Drawings. Test shall include full range of movement, stability through that range, and power and/or control signal failure performance. Operators found to be non-functional in any way shall be replaced.

VERIFY OPERATOR AND SYSTEM FUNCTIONALITY

Verify backup system operations and switchovers including redundant processors, backup power supplies, battery backed memories, etc.

Verify DDC system command software by issuing commands at the operator's console and observing display or HVAC equipment responses. The following software operation shall be verified:

Software for checking input commands and issuing error messages. Enter various correct and incorrect commands.

System and point addressing check. Enter command to display I/O data. Verify all data points defined on the drawings and/or required by the specifications.

Start-stop or enable-disable of HVAC equipment or DDC system control points. Enter commands to start/stop selected HVAC equipment, and to disable and enable selected points.

Operator override/automatic mode. Enter command to change selected automatic control under DDC system to manual and vice versa.

Display format. Enter commands to display data and graphics on terminal and graphic display. Check display content for adequacy and clarity as specified.

Ability to modify, cancel and confirm operator's commands. Verify by entering commands.
Set-point adjustment and limiting. Enter commands to adjust set points of controllers and range limits of the controlled media. Verify by display. Also enter commands to adjust set-points outside their range limits. DDC system shall display error messages.

System access and access level control. Try to log on to system with both incorrect and correct ID codes. Try to enter different commands with different access level of the operators. The responses of the DDC system shall be as specified.

Start/stop equipment. Enter command to start or stop selected equipment. Also reset time to initiate automatic mode. Verify responses by observation of equipment and DDC system display.

Change parameter of points. Enter commands to change parameters of selected points such as high and low limit alarms, scale factor, etc. to test the adequacy of software.

Verify graphic display of each HVAC system and component. Confirm that the graphic is in accordance with the design data and reviewed submittals, includes all data points required, displayed data is correct and in the correct format and units, and changes in point conditions or status are accurately updated. Evaluate the refresh rate of data display.

Verify report generation (status, profile, energy, etc.) by entering commands to generate reports such as all points, trend, total display of a system, timed display, and other specified reports. Examine the report content for general format, system/point code, time interval of reporting, point status/value/unit, energy amount/rate/unit, status of control and set time (manual or automatic), and other specification required information.

Check for proper operation of system status reports, including point status reviews which would include information such as points currently in alarm, points removed from alarm checking, points off of scan, etc.

Test alarm reporting by initiating alarm conditions of different points at different alarm levels in sequence to examine alarm reports. The reports shall show alarm location and device, alarm time, cause of alarm, current status of the point, etc. as required in the specifications. When alarm conditions are removed the printer shall print updated status report. Also verify audible alarm operations in accordance with specification requirements. Then initiate alarm conditions at different levels at the same time to check alarm priority.

Trending performance shall be tested by creating trend logs for each control sequence and monitoring the trend reports throughout the period that each control sequence is tested.

TEST CONTROL SEQUENCES

General: The test procedures described below do not check the details of the software, rather, they try to verify the final output as indicated by the field equipment. Before testing each program the required input and output of the program and those listed in the contract specifications shall be compared to make sure that the program covers the specified operations. Verification of HVAC equipment operation (such as equipment status or temperature of space air) may be done by either (1) actual observation of equipment status and test instruments, or (2) obtaining DDC system reports if the accuracy of these reports has been verified previously.

Basic Functional Tests: Through the user interface conduct the following series of tests:

Raise/lower space temperature setpoints in software to verify if the system responds in accordance with design requirements.

Raise/lower AHU discharge temperature setpoints and verify control valve and damper positions.

Raise/lower static pressure setpoints and verify variable speed drive or vortex damper control.

Initiate a high priority, off-hours alarm and verify that the remote notification procedures are carried out correctly.

Verify that the interface with system safeties allow operation of dampers, etc., if safety conditions are met.

Conduct an emergency start-up after power failure test. Verify that all systems return to automatic control.

Verify DDC system maintains required outside air requirements under low airflow conditions.

Disconnect communication cable to the DDC system and verify if the DDC panel can control the respective system (stand-alone control).

Disconnect a sample of DDC space-temperature sensors and verify control sequence default.

Test HVAC Systems Sequences of Operation:

Scheduled start-stop control. Verify that input includes start/stop time and days for specified equipment. Verify input for time delays of specified equipment. Check holiday effect. For each air handler, log operation for at least three days to confirm that unit starts and stops in accordance with the schedule.

Optimum start-stop control. Verify that the required input includes space temperature, outdoor temperature, occupied time and days of the week, and the response time of the air handling equipment, on an individual system by system basis. For each air handler, log space temperature for at least three days to confirm that space is at required temperature by the start of the occupied period.

Electrical demand limiting control. Verify required input data, as follows: electrical loads under control, load priority, demand metering interval, demand limit setpoint, delay time, minium off-time, minimum on-time, and maximum off-time. Test control by the following process:

Override demand sensor and input demand limit setpoint 10% lower than current electrical consumption rate (kW).

Confirm equipment shutdown by observation of equipment and/or display.

Day-night setback control. Confirm that required input data is provided. To test control, change the setback time from occupied to unoccupied time and confirm that HVAC systems respond to the setback mode. If system is an air-handling system, the outside air damper should close and the fan should cycle to maintain the setback temperature setpoint.

Change the setback temperature setpoint to 5°F higher than the actual space temperature. The system should operate to increase the space temperature to the new setpoint condition. For air-handlers, the outside air damper should remain closed.

Economizer cycle control. If the outdoor air temperature is above the discharge air temperature setpoint, but below the defined 100% outdoor air changeover temperature setpoint, verify that the outside air damper is fully open, the return air damper is fully closed, and that the air-handler discharge air temperature is maintained by modulation of the chilled water control valve.

Heating/cooling coil discharge temperature reset. Verify that the required input points are provided and that the coil discharge air temperature setpoint is in accordance with the input conditions and the sequence of operation defined on the control drawings.

Hot water temperature reset. Verify that the required input points are provided and that the heat exchanger supply hot water temperature setpoint is in accordance with the input conditions and the sequence of operation defined on the control drawings.

Chilled water temperature reset. Verify that the required input points are provided and that the chilled water supply temperature setpoint is in accordance with the input conditions and the sequence of operation defined on the control drawings.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 230923

SECTION 230993 - SEQUENCES OF OPERATION

PART 1 - GENERAL

SCOPE

This section includes basic requirements for sequences of operation for Division 23 equipment, as well for equipment furnished under other Divisions.

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to the work of this section.

The requirements of Sections 230913, 230923, 230924, and 290933 apply to the work of this section.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Sequences of Operation: Provide complete documentation of the sequences of operation required by this project, as hereinafter specified:

Include narrative sequence of operation for each HVAC system, subsystem, and component as defined herein, within other specification sections referenced herein, and/or defined on the project Drawings.

Narratives shall not be verbatim copies of the sequences provided herein, but shall reflect the actual sequence of operation as applied by the contractor.

Sequences of operation must include setpoints and/or control ranges, digital alarms, analog alarm setpoints (both high and low), time delays, I/O point names, hardware/software interlocks, analog control mode (e.g., proportional [P] or proportional plus integral [PI]), and any other specifics needed for the user to fully understand and utilize the DDC system for operation of each HVAC system and its individual components in compliance with the design intent.

Sequences of operation for each item of equipment that is controlled by integral original equipment manufacturer (OEM)controls, with or without control logic through the DDC system, shall be incorporated in the applicable narrative.

Control Schematics: Provide schematic diagrams of each HVAC system/subsystem sufficient to define the location of all control sensors, final control devices, etc. that are utilized as part of any sequence of operation and that confirm all input and output points required by any sequence of operation.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

GENERAL REQUIREMENTS

Sequences of operation specified herein, which indicate the functional intent of HVAC systems, subsystems, and/or components operation, are general in nature and may not fully define every aspect of programming that may be required to fulfill the design intent. **Contractor shall provide all programming necessary to obtain the sequences/system operation indicated, resulting in stable HVAC system operation in accordance with the design intent.**

The following standard abbreviations, along with abbreviations defined on the Drawings, shall apply to all control schematics and sequences:

Abbreviation	Definition	Abbreviation	Definition
I/O Points		*HVAC Components/Conditions*	
AI	Analog Input	ACWS, ACWR	Air-Conditioning Water Supply, Return
AO	Analog Output	AHU	Air-Handling Unit
AV	Analog Value	BCU	Blower Coil Unit
DI	Digital (Binary) Input	CAV	Constant Air Volume
DO	Digital (Binary) Output	CC	Cooling Coil
DV	Digital (Binary) Value	CHWS, CHWR	Chilled Water Supply, Return
Control Conditions/Actions		FCU	Fan Coil Unit
BP	Barometric Pressure	HC	Heating Coil
BTU	British Thermal Unit	HWS, HWR	Hot Water Supply, Return
DA	Direct Acting	OA	Outdoor Air
DB	Dry Bulb	OEM	Original Equipment Manufacturer
DP	Differential Pressure	PHC	Preheat Coil
DPT	Dew Point Temperature	RA	Return Air
DT	Differential Temperature (Range)	RF	Return Air Fan
NC	Normally Closed	SA	Supply Air
NO	Normally Open	SF	Supply Fan
P	Pressure; Proportional	VA	Ventilation Air
RA	Reverse Acting	VAV	Variable Air Volume
SP	Static Pressure	XA	Relief Air
T	Temperature	XF	Relief Air Fan
TP	Total Pressure		
VP	Velocity Pressure		
WB	Wet Bulb		

Sequences of operation shall incorporate the following control point/object requirements:

Point Description	Hardware Point				Software Point				GRAPHIC
	AI	AO	DI	BI	AV	DV	SCHED	TREND	
BTU	X							X	X
Damper End Switch			X						X
DP	X							X	X
DPT					X			X	X
DT					X			X	X
Drain Pan Water Level Sensor			X						X
Electrical Power	X							X	X
Enthalpy					X			X	X
Flow (Air, Water, etc.)	X							X	X
Gas Concentration	X							X	X
Humidity	X							X	X
Occupancy/Vacancy			X					X	X
Occupied/Unoccupied				X			x	X	X
On/Off				X			x	X	X
Open/Close				X				X	X

Point Description	Hardware Point				Software Point				GRAPHIC
	AI	AO	DI	BI	AV	DV	SCHED	TREND	
Output (Percent)		X						X	X
Position (Percent from Normal)					X			X	X
P	X							X	X
Speed (%, setpoint)		X						X	
Speed (%, feedback)	X							X	X
Status			X					X	X
T	X							X	X

All sequences of operation are based on one or more sensed variables, with an associated controlled variable, changing in one direction. **Each sequence shall operate in reverse when the sensed variable(s) changes in the opposite direction.**

HVAC control setpoints are defined or implied within the sequences of operation specified hereinafter and/or elsewhere on the Drawings.

Where a setpoint is not explicitly defined or implied, determine the appropriate setpoint based on scheduled performance data for HVAC equipment. **Confirm setpoint with A-E**.

Defined or implied setpoints and setpoint reset requirements shall, as necessary, be adjusted based on test data provided by the testing/adjusting/balancing (TAB) subcontractor and control system calibration and verification testing as required by Section 230923 to provide stable, satisfactory HVAC systems operation in compliance with the design intent.

AO setpoints and control ranges shall be user-adjustable.

DO points that depend on a specific analog value to change shall be user-adjustable.

The minimum speed setting for each pump and fan under VFD control shall be as low as possible, while avoiding inertial stalling. Adjust each VFD minimum speed and ramp-up and -down times based on test data provided by the TAB subcontractor. Default times for acceleration/deceleration shall be 30 seconds for motors less than 40 hp and 60 seconds for motors 40 hp and larger.

Two independent schedules for HVAC system operation and control are required by Sequence 1.14, established as follows:

"ON/OFF" schedule(s) shall determine HVAC systems and/or equipment start/stop times, define applicable operating setpoints, and define when specific sequences of operation are to be utilized.

“ON” hour is defined as the estimated latest hour at which the HVAC system/equipment may be “ENABLED” and commanded “ON” so that setpoint conditions are maintained within the space(s) served at the “OCCUPIED” start hour. This “ON” hour shall be adjusted by the “Optimum Start” application specified in Section 230923.

“OFF” hour is defined as the hour at which the HVAC system/equipment shall be “DISABLED.”

"OCCUPIED/UNOCCUPIED" schedule(s) shall determine ventilation modes.

These schedules define 5 specific operating periods for the HVAC systems to which they are applied:

“On” period is the elapsed time between the scheduled “On” hour, defined as the latest allowable hour at which the HVAC system must be “On,” and the “Off” hour, during which the HVAC operates to maintain the spaces served at the defined “On” period temperature and/or humidity setpoints.

“Off” period is the elapsed time between the scheduled “Off” and “On” hours during which the HVAC system does not operate unless it is required to cycle “On” to maintain the spaces served at the defined “Off” period high and low limit temperature and/or humidity setpoints.

“Occupied” period is the elapsed time between the scheduled “Occupied” start and end hours during which people, to a greater or lesser extent, are expected to be present and required ventilation air.

"Unoccupied" period is the elapsed time between the scheduled "Occupied" end and start hours during which people, except at *de minimis* levels, are not expected to be present and, therefore, no ventilation air is required.

"Pre-Occupied" period is the elapsed time between the scheduled "On" hour and the actual "On" hour computed by the Optimum Start algorithm so that setpoint conditions are maintained within the space(s) served at the beginning of the "Occupied" period. (This period typically overlaps the "Unoccupied" period by 1-3 hours depending on input schedules.)

Provide operator-defined maintenance "lockout" for each HVAC component. When initiated, any component defined to be locked out for maintenance shall be deleted from any applicable control sequence of operation.
Where sequences call for "Lead/Lag" or "Rotating Start/Stop" for equipment, provide control algorithm so that each equipment module is commanded "ON" in sequence in reverse relationship to the modules' runtimes (I.E., the module with the least number of run hours is the first on started, etc.). Each equipment modules shall be commanded "OFF" or "STOP" in sequence in direct relationship to the modules' runtimes (I.E., the module with the greatest number of run hours is the first on stopped, etc.).

Were indicated on the plans or in the sequences, locate room controller(s) or room sensor(s) adjacent to and at same height as space light switch(es). Were feasible, multiple controllers/sensors shall be incorporated within a common device or enclosure.

SEQUENCES OF OPERATION

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	4.01	Space Temperature/Humidity Setpoints and Monitoring
	4.05	Drain Pan Condensate Level Alarm
	4.06	Filter Differential Pressure Alarm
	4.07	Low Limit Thermostat Control and Alarm
	4.08	Preheat Control
	4.09	Adiabatic Type Duct Humidifier

Section	ID	Description
4.2 Multiple Zone Single Duct Air-Handling Systems		
	4.20	Multiple Zone Single Duct Air-Handling Systems, Operations and Monitoring
	4.21	Discharge Air Temperature Control, Multiple Zone System
	4.22	Airflow Volume Control, Multiple Zone System
	4.26	"OFF" Period Space Temperature/Humidity Control, Multiple Zone System
	4.27	Terminal Unit Control, Single Duct
	4.27.3	VAV Terminal Reheat, Single Maximum Airflow Setpoint
4.3 Fan Coil Units		
	4.31	Temperature Control
5.2 Packaged DX Units		
	5.20	Packaged/Split Air-Cooled DX Unit, VAV Multiple Zone System
SPECIAL EXHAUST SYSTEMS		
7.1 Conservation Exhaust		
	7.13	Typical Conservation Space: Room Controls
	7.14	Conservation Workroom 258E: Room Controls
	7.15	Laboratory: Fume Exhaust, Variable Air Volume, Multi-Fan Manifold
AIR-TO-AIR HEAT RECOVERY		
8.1 Energy Recovery		
	8.10	Run-Around Air-to-Air Heat Recovery

GENERAL DDC SEQUENCES

1.10 **Emergency Stop Control:**

The following elements shall be incorporated into sequences of operation, **whether specifically defined in individual sequences of operation hereinafter or no**t, and shall initiate an alarm upon occurrence of any emergency stop:

Application	Configuration	Emergency Stop Requirements	
FCU/BCU/AHU supply air fan(s) and return/relief/exhaust air fan(s).	Unit serves a single space and is incapable of spreading smoke beyond the space in which smoke is generated.	Duct smoke detectors not required. Emergency stop by fire alarm system shutdown relay/software interlock not required.	
	Unit serves multiple spaces and is capable of spreading smoke beyond the space in which smoke is generated.	Unit airflow ≤ 2,000 cfm	No duct smoke detectors required. Emergency stop by fire alarm system shutdown relay/ software interlock not required.
		Unit airflow > 2,000 cfm	Duct smoke detectors required in both unit return air and supply air. Emergency stop of all unit fans shall be initiated by auxiliary contacts of duct smoke detectors or by fire alarm system shutdown relay/software interlock.
	CAV unit with minimum outdoor airflow (no economizer cycle).	Low limit thermostat not required.	
	CAV or VAV unit with economizer cycle operation.	Low limit thermostat required when any coil utilizes water or as primary heat transfer medium. (See Sequence 4.07)	
	Unit with return or relief fan(s).	If a supply fan is stopped by any safety interlock, all associated supply and return/relief fan(s) shall be commanded "OFF" via software interlock. If return/relief fan(s) is stopped by any safety interlock, the associated supply fan(s) shall be commanded "OFF" via software interlock.	

1.14. **Schedules of Operation**:

AHU-1 shall be enabled 24/7. Schedule shall be set up in BAS system for future and initially set to 24/7.

System(s)	Period	Hours (1-24) Each Day of The Week							Weeks to Apply (1-52)
		MON	TUE	WED	THR	FRI	SAT	SUN	
	"ON" Hour for Latest System Start								
	"OFF" Hour to Stop System								
	Occupied Period Start Hour								
	Occupied Period End Hour								

1.18 **Input Point Monitoring and Alarm Initiation**

Digital inputs (DI or DV):

MONITOR each DI and DV point for alarm condition.

MONITOR each motor status and initiate alarms in accordance with Sequence 1.25.

Set digital point alarm condition the basis of field adjusted differential setpoints.

Where start/stop or other two-position control sequence is based on a digital input status condition or input sensed variable value(s) (AI or AV), set time delays or digital filters to prevent any equipment item or final control element from "short-cycling" in response to small changes of the sensed variable(s).

Incorporate user-adjustable time inhibit alarm(s) to prevent nuisance alarms and/or "tripping" under normal operation and during equipment start-up and shut-down.

For devices that have Form "C" relay contacts available for alarm monitoring, use NC contacts for the "Off" or "Normal" condition and NO contacts on "Alarm" condition.

Analog inputs (AI or AV):

Set high and/or low alarm setpoints for each point.

The following default values shall be used if alarm setpoints are not defined within a specific sequence operation or indicated on the Drawings:

Space temperature	5ºF below low setpoint of comfort zone or 5ºF above high setpoint of comfort zone
Space humidity	≥70% RH
AHU mixed air low limit	≤38ºF
Cooling coil leaving air	≥60ºF
Heating coil leaving air	≤90ºF
CHW supply	≥48ºF
HW supply	≤120ºF

Ensure that status alarm conditions are implemented for each DI point and high and/or low alarm setpoints are defined for all AI points.

1.20 **Output Point Control**

Set each control loop to utilize one of the following control modes:

Digital (binary) output: Two position (e.g., on-off, slow-fast)

Analog output: Proportional (P) or proportional + integral (PI) function control, as follows:

Controlled Variable	Control Mode
Space Temperature	P
Mixed Air Temperature	PI
Coil Discharge Temperature	PI (cooling), P (heating)
Chilled Water Supply Temperature	PI
Hot Water Supply Temperature	P
Airflow	PI (with wide proportional band and fast reset rate)
Fan Static Pressure (Fan Speed)	PI
Humidity	P
Other (not listed above or indicated on the Drawings)	**Consult A-E**

Analog output proportional band and gain setpoints:

Set on basis of actual sensor span, zero bias, and minimum proportional bands/throttling ranges, as follows, for all analog control loops to prevent "hunting:"

Set proportional bands/throttling ranges to provide stable control around setpoints and as determined on an individual point basis **based on test data provided by the TAB subcontractor**.

Default deadbands/throttling ranges are as follows

Space temperature (cooling)	± 1.5°F
Space temperature (heating)	± 2.0°F
Space humidity	± 5% RH
Mixed/discharge air temperature	± 0.25°F
CHWS temperature	± 0.50°F
HWS/ACWS temperature	± 2.0°F
Duct/plenum static pressure	± 0.05” wg
Airflow (cfm) and water flow (gpm)	± 2% of design flow
Water pressure	± 0.25 psi

Analog output integral gain setpoint:

Set to bring the measured variable to its setpoint without abrupt changes to HVAC equipment operation and to limit every control loop output signal to a maximum rate of change of 25% per minute.

Only if this found to be impossible, may the proportional gain, as determined above, be adjusted.

Analog output derivative gain setpoint:

Derivative function for any control loop is prohibited unless reviewed by the A-E for each specific point. Set derivative gain to 0.

Setpoint reset: For air or water systems in which the sequence of operation requires temperature, pressure, etc. setpoint to be reset based on valve or damper position of the zone(s) requiring cooling or heating, the following method shall be employed:

A floating reset algorithm shall be used that increments the secondary variable (e.g., temperature, pipe or duct pressure) setpoint on a periodic basis to maintain primary variable (e.g. cooling valve, heating valve, damper position) setpoint of 85% open. The reset increment shall be calculated based on the average position of the quantity of the worst (most open valve/damper) zone(s) as specified. **The recalculation time, reset increment and control device position influence shall be chosen to maintain the primary variable within the specified maximum allowable variance while minimizing overshoot and settling time.**

Final control element operation:

Normally open/normally closed: Two-way final control element position in response to 0% control loop output signal. Except as otherwise specified herein or indicated on the Drawings, “OFF” or “NORMAL” position of final control elements shall be as follows:

Final Control Element	Off/Normal Position
Reheating coil control valve	closed
Heating/Preheating coil control valve	open
Cooling coil control valve	open
Outside air damper	closed
Return air damper	open
Exhaust/relief air damper	closed

Direct acting/response: 0% to 100% change of final control element state or position in response to 0% to 100% control loop output signal.

Reverse acting/response: 100% to 0% change of final control element state or position in response to 0% to 100% control loop output signal.

1.21 **Constant Speed Single-Phase or Polyphase Motor Control**:

Motor shall be commanded “ON/OFF” via DO point.

MONITOR motor status as DI point in accordance with Sequence 1.25.

Emergency stop:

Hard-wired contact(s) shall “STOP” motor in accordance with motor emergency stop requirements defined hereinbefore.

Initiate alarm upon emergency stop.

1.23 **Variable Speed Single-Phase Motor Control**:

Provide interface between DDC system and manufacturer-provided electronically commutated motor (ECM) integral speed controller.

Command motor “ON/OFF” via DO point.

MONITOR motor status as DI point in accordance with Sequence 1.25.

Emergency stop:

Hard-wired contact(s) shall “STOP” motor in accordance with motor emergency stop requirements defined by Sequence 1.10.

Initiate alarm upon emergency stop.

Modulate motor speed from minimum speed to 100% speed in direct response to AO point.

Adjust minimum speed setpoint to value, as reviewed by A-E, using the following procedure:

Manually set ECM controller minimum speed output to 6 Hz (10% of maximum) unless (1) dictated otherwise by the equipment manufacturer or (2) defined otherwise by sequence(s) of operation. Observe driven equipment to ensure that it is visibly rotating.

If not, increase controller minimum speed output in increments of 2 Hz until the unit driven equipment is visibly rotating.

Ensure that the current sensing relay required by Sequence 1.25 confirms operation at the minimum speed setting.

Initiate alarm via DI point if ECM controller status/fault contact closes.

1.24 **Variable Speed Polyphase Motor Control**:

Provide interface between DDC system and manufacturer-provided variable frequency drive (VFD) for motor speed control.

Command motor “ON/OFF” via DO point.

MONITOR motor status in accordance with Sequence 1.25.

Emergency stop:

Hard-wired contact(s) shall “STOP” motor in accordance with motor emergency stop requirements defined by Sequence 1.10.

Initiate alarm upon emergency stop.

Modulate motor speed from minimum speed to maximum speed in direct response to AO point.

Set minimum speed setpoint to value, as reviewed by A-E, using the following procedure:

Manually set VFD minimum speed output to 6 Hz (10% of maximum) unless (1) dictated otherwise by the equipment manufacturer or (2) defined otherwise by sequence(s) of operation herein defined.

Observe driven equipment to ensure that it is visibly rotating. If not, increase controller minimum speed output in increments of 2 Hz until the unit driven equipment is visibly rotating.

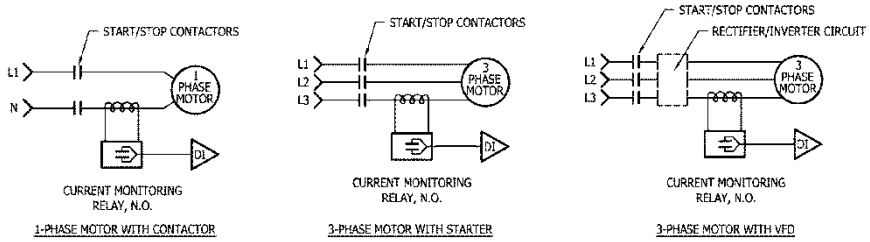
Ensure that the current sensing relay required by Sequence 1.25 confirms operation at the minimum speed setting.

Set maximum speed setpoint to value determined during TAB operations in order to obtain design flow.

MONITOR motor speed feedback from VFD via AI point.

Initiate alarm via DI point if VFD status/fault contact closes.

1.25 **Single-Phase and Polyphase Motor Status Monitoring**:



Motor "ON" or "OFF" status shall be determined via DI point contact closure by current monitoring relay as illustrated above.

Adjust current monitoring relay “trip” setpoint to 5% above the minimum operating motor amperage.

For variable speed motors, coordinate “trip” setpoint with minimum motor speed.

Monitor motor status anytime motor has been commanded “ON.”

Inhibit motor status monitoring for the first 10 seconds after motor is commanded “ON.”

If motor status DI point indicates motor failure:

For single pump or fan configurations, command motor “OFF,” terminate associated start sequence, and initiate pump/fan failure alarm.

For fans operating in lead/standby configuration in accordance with Sequence 1.26.2, command operating fan “OFF,” command standby fan “ON,” and initiate fan failure alarm.

If standby fan motor status DI point indicates motor failure, terminate associated start sequence and initiate fan failure alarm.

For multiple fans operating in parallel lead/lag/cascade configuration in accordance with Sequence 1.26.1, command failed fan “OFF,” initiate fan failure alarm, and continue associated start sequence with remaining fan(s) in operation.

If two or more motor status DI points indicate motor failure, command all motors “OFF,” terminate associated start sequence, and initiate fan failure alarm.

1.26.1 **Lead/Lag/Cascade Sequencing of Parallel-Configured Components**:

DDC system shall incorporate “Lead/Lag” sequence as part of any sequence of operation requiring sequential “ON/OFF” staging and cascading of multiple HVAC components designed to operate in parallel, as follows:

Designate HVAC each component as “Lead” in the **reverse order** of its number of operational hours.

Designate HVAC each component as “Lag” in the **direct order** of its number of operational hours.

1.26.2 **Lead/Standby Sequencing of Alternating Components**: DDC system shall incorporate “Lead/Standby” sequence as part of any sequence of operation requiring the “ON/OFF” alternating use of two or more HVAC components, as follows:

Designate HVAC components as “Lead/Standby” on a weekly schedule to equalize operational hours of each HVAC component.

1.27 **Exhaust Fan Start/Stop**: Exhaust fan start/stop control methods shall be as indicated on the Drawings, in accordance with the following:

Indicated Control Method	Exhaust Fan Start/Stop Control Method
DDC (Interlock)	Start/stop exhaust fan(s) in accordance with (1) associated air-handling system "OCCUPIED/UNOCCUPIED" schedule or (2) operator command in compliance with Sequence 1.21.
DDC (Temperature)	Start and stop exhaust fan(s) based on (1) space temperature or (2) operator command in compliance with Sequence 1.21. On a rise in space temperature to above setpoint, exhaust fan shall be energized to maintain space temperature at setpoint. Space temperature setpoint shall be 80°F. MONITOR space temperature as AI point.
Independent Thermostat	Start/stop exhaust fan(s) based on stand-alone, wall-mounted line-voltage thermostat; no DDC connection required. On a rise in space temperature to above setpoint, exhaust fan shall be energized to maintain space temperature at setpoint.
Manual	Start/stop exhaust fan(s) via manual switches or breakers. See Division 26 Drawings, as applicable.

1.30 **Outdoor Piping/Equipment Trace Heating Cable**: On a fall in liquid temperature to below setpoint, trace heating cable, where indicated on the Drawings, shall be energized by pipe surface mounted line voltage thermostat ("aquastat") to maintain liquid temperature at setpoint.

1.33 **Final Control Element Operators (Valves and Dampers)**:

Two-position control operator shall "OPEN" or "CLOSE" final control element (valve/damper), as indicated on the Drawings, in direct response to DO point.

MONITOR final control element position as DI point equal to the DO point.

Final control element position shall be confirmed by visual inspection during the calibration and verification procedures required by Section 230923.

Modulating control operator shall modulate 0% to 100% from its Normal state, as indicated on the Drawings, in direct response to AO point.

MONITOR final control element position as AI point whose value (percent) is equal to the AO point value (percent).

Final control element position shall be confirmed as equal to the AO point value (percent) during the calibration and verification procedures required by Section 230923.

1.39 **Electric Resistance Heating Coil Control**:

Silicon Control Rectifier (SCR) Control: Interface with SCR type controller via AO point to modulate heating capacity, as scheduled on the Drawings, from 0% to 100% in accordance with indicated sequence of operation.

SITE CONDITIONS AND UTILITIES

2.01 **Outdoor Air Conditions**:

MONITOR ambient outdoor air conditions as AI points:

DB Temperature (ºF)
RH (%)

Compute enthalpy (Btu/Lbm) as AV point as a function of monitored DB and RH.
Compute DPT (ºF) as AV point as a function of monitored DB and RH.
Compute WB temperature (ºF) as AV point as a function of monitored DB and RH.

AI and AV point values shall serve as global inputs to any sequence of operation requiring an ambient outdoor air condition as a control or computational variable.

CENTRAL PLANTS

3.14 CHILLED WATER SYSTEMS

3.14.1 Chilled Water System, Multiple Chillers, Primary-Secondary Variable Flow:

System start sequence shall be as follows:

MONITOR differential pressure at location(s) indicated on the Drawings as AI point(s).

If differential pressure sensor(s) falls below setpoint and the chilled water valves are at 90%, open isolation valve at pump, close isolation valve on bypass, and command chilled water pump "ON" via DO point(s) in accordance with Sequence 1.24.

Confirm pump operation based on motor status via DI point in accordance with Sequence 1.25.
Confirm loop water flow via differential pressure switch DI point.

Modulate chilled water pump speed to maintain differential pressure(s) at setpoint.

During TAB of secondary chilled water distribution, adjust differential pressure setpoint(s) to value(s) recommended by TAB subcontractor, as reviewed by A-E.

When chilled water valves are at 70%, command pump “OFF” and close isolation valve at pump, open isolation valve on bypass.

3.2 HOT WATER SYSTEMS

3.23 Hot Water System, Multiple Non-Condensing Boilers, Primary-Secondary Variable Flow:

System start sequence shall be as follows:

MONITOR differential pressure at location(s) indicated on the Drawings as AI point(s).

If differential pressure sensor(s) falls below setpoint and the hot water valves are at 90%, open isolation valve at pump, close isolation valve on bypass, and command hot water pump "ON" via DO point(s) in accordance with Sequence 1.24.

Confirm pump operation based on motor status via DI point in accordance with Sequence 1.25.
Confirm loop water flow via differential pressure switch DI point.

Modulate hot water pump speed to maintain differential pressure(s) at setpoint.

During TAB of secondary chilled water distribution, adjust differential pressure setpoint(s) to value(s) recommended by TAB subcontractor, as reviewed by A-E.

When hot water valves are at 70%, command pump “OFF” and close isolation valve at pump, open isolation valve on bypass.

AIR-HANDLING SYSEMS

4.0 GENERAL AIR-HANDLING SYSTEMS OPERATIONS AND MONITORING

4.00 **Start/Stop Control**:

Start/stop air-handling system supply air fan(s) and associated exhaust air fan(s) in accordance with Sequence 1.21, 1.23, or 1.24, as applicable, based on (1) user-defined "ON/OFF" schedule defined by Sequence 1.14 or (2) operator command.

During "ON" periods, command air-handling system "ON" (start) unless inhibited by operator command, or an emergency stop interlock in accordance with Sequence 1.10.

During "OFF" periods, command air-handling system "OFF" via DO point unless there is a need for heating, cooling, or dehumidification as evidenced by space temperature or humidity being out of zone “OFF” period low or high limit setpoint(s) defined by Sequence 4.01.

Each exhaust fan associated with an air-handling system, as tabulated below, shall be commanded "ON" via DO point when the air-handling system is "ON" and commanded "OFF" via DO point when the air-handling system is "OFF," in accordance with Sequence 1.27:

Air-Handling System Tag	Exhaust Fan Tag	Area(s) Served
AHU-1	LEF-1	Conservation

MONITOR fan motors(s) status via DI point(s) in accordance with Sequence 1.25.

MONITOR supply fan pressures as DI points at two locations:

High limit static pressure (locate immediately downstream of the fan).

During TAB of air-handling system, adjust setpoint to value recommended by TAB subcontractor, as reviewed by A-E.

If high limit static pressure exceeds setpoint unit shall be disabled via hardwire inter-lock, command system “OFF” via DO point.

Issue high pressure alarm.

Low limit static pressure (locate immediately upstream of the fan).

During TAB of air-handling system, adjust setpoint to value recommended by TAB subcontractor, as reviewed by A-E.

If low limit static pressure falls below setpoint unit shall be disabled via hardwire interlock, command system “OFF” via DO point.

Issue low pressure alarm.

MONITOR LEF-1 fan pressures as DI:

Low limit static pressure (locate immediately upstream of the fan).

During TAB of air-handling system, adjust setpoint to value recommended by TAB subcontractor, as reviewed by A-E.

If low limit static pressure falls below setpoint unit shall be disabled via hardwire interlock, command system “OFF” via DO point.

Issue low pressure alarm.

4.01 **Space Temperature/Humidity Setpoints and Monitoring**:

Space temperature and humidity control setpoints for Conservation:

"ON" Period:	Temperature Range:	68-72ºF Comfort Zone
	Max. Humidity:	50% RH High Limit
	Min. Humidity:	40% RH Low Limit
"OFF" Period:	Max. Temperature:	72ºF High Limit
	Min. Temperature:	68ºF Low Limit
	Max Humidity:	50% RH Low Limit
	Min. Humidity:	40% RH High Limit

Space temperature and humidity control setpoints for Classroom:

"ON" Period:	Temperature Range:	70-75ºF Comfort Zone
	Max. Humidity:	50% RH High Limit
"OFF" Period:	Max. Temperature:	85ºF High Limit
	Min. Temperature:	60ºF Low Limit
	Max. Humidity:	60% RH High Limit

Space temperature setpoints shall **not** be adjustable by space occupants.

Space humidity setpoints shall **not** be adjustable by space occupants.

MONITOR each space temperature and humidity as individual AI point.

Cooling/Heating “REQUESTS” for Central Plant Start/Stop Control:

For spaces served by multiple zone air systems:

A “REQUEST FOR COOLING” shall be initiated when at least one (1) space sensors indicate a space temperature rising above either the maximum comfort zone temperature setpoint during “ON” periods or the high limit temperature setpoint during “OFF” periods or a space humidity rising above or falling below the humidity limit setpoints for a period of 30 minutes.

A “REQUEST FOR HEATING” shall be initiated when at least one (1) space sensors indicate a space temperature falling below either the minimum comfort zone temperature setpoint during “ON” periods or the low limit temperature setpoint during “OFF” periods or a space humidity rising above or falling below the humidity limit setpoints for a period of 30 minutes.

4.05 **Drain Pan Condensate Level Alarm**:

MONITOR drain pan condensate level sensor integral NO dry contact as a DI point.

Upon sensor detection of drain pan moisture, and after user-defined time delay (default = 3 minutes), stop air-handling system via DO point and initiate an alarm.

4.06 **Filter Differential Pressure Alarm**:

MONITOR filter differential pressure gauge integral NO dry contact as DI point.

Upon filter differential pressure exceeding setpoint, initiate maintenance alarm for filter replacement.

4.07 **Low Limit Thermostat Control and Alarm**:

Stop air-handling system fan(s) via hardwired interlock when low limit air temperature falls to 38ºF.

MONITOR low limit thermostat auxiliary SPDT line voltage switch as DI point and initiate the following actions when thermostat "trips":

In accordance with Sequence 4.08, as applicable, initiate maximum preheating capability.

Modulate chilled water coil control valve via AO point to provide 25% cooling capacity to keep flow through the system.

Initiate alarm.

4.08 **Preheat Control**:

Preheat temperature setpoint shall be the air-handling system discharge air temperature setpoint or the humidifier preheat setpoint.

MONITOR preheat coil temperature as AI point.

Hot water preheat coil with circulating pump:

Provide modulating hot water control valve and circulating pump as detailed on the Drawings.

On a fall of preheat coil temperature to below setpoint, command preheat coil hot water pump "ON" via DO point to provide 100% water flow through coil and modulate NC preheat hot water control valve via AO point to maintain discharge preheat discharge air at setpoint.

4.09 **Adiabatic Type Duct Humidifier**:

"ENABLE" humidifier operation if air-handling system is "ON," the supply air fan is operating at ≥ 20% speed.

If space humidity falls below low limit humidity setpoint as defined in Sequence 4.01, preheat coil shall control to 96° F and humidifier shall modulate to maintain space humidity at low limit humidity setpoint.

MONITOR supply air humidity ***downstream of humidifier absorption zone*** as AI point.

Limit humidifier AO point value to maintain downstream humidity at maximum 90% RH.

DISABLE humidifier operation if any ENABLE condition is/becomes not true.

4.2 MULTIPLE ZONE SINGLE DUCT AIR-HANDLING SYSTEMS

4.20 **Multiple Zone Air-Handling System, Operations and Monitoring**:

The following sequences of operation shall apply to AHU-1:

Basic control elements (Sequences 1.xx and 2.xx, as applicable)
General operations and monitoring
Start/stop control (Sequence 4.00)
Drain pan condensate monitoring (Sequence 4.05)
Filter differential pressure monitoring (Sequence 4.06)
Low limit thermostat alarm (Sequence 4.07)
Preheat (Sequence 4.08)
Adiabatic Humidifier (Sequence 4.09)
Variable air volume supply air control
Discharge air temperature control (Sequence 4.21)
Supply fan air volume control (Sequence 4.22)
Space temperature and humidity control via terminal units (Sequences 4.26 and as follows)
Single duct, VAV terminal reheat, single maximum airflow setpoint (Sequence 4.27.3)

4.21 **Discharge Air Temperature Control, Multiple Zone System**:

During “ON” periods, define discharge air temperature setpoint, as follows:

MONITOR discharge air temperature as AI point.

MONITOR exhaust air temperature and humidity as individual AI points.

Set discharge air temperature setpoint initially to 53 deg F.

Reset discharge air temperature setpoint via AV point as follows:

Routinely (at least every 5 minutes), evaluate space temperature conditions to identify potential over-cooling. If all space temperatures are below cooling setpoint deadband **increase** discharge air temperature setpoint by 0.5ºF up to a maximum of 60 deg F until a space temperature rises above the cooling setpoint. Upon a space temperature rising above cooling setpoint the reverse shall occur.

Routinely (at least every 5 minutes), evaluate space humidity conditions to identify potential high humidity. If humidity in any space served exceeds the high limit humidity setpoint for that space, **decrease** discharge air temperature setpoint by 0.5ºF until all space humidity conditions are at or below the space high limit humidity setpoint.

Modulate NO cooling coil chilled water control valve via AO point from 0% to 100% “OPEN” to maintain discharge air temperature at setpoint.

During “OFF” periods, DISABLE discharge air temperature setpoint.

4.22 **Supply Air Fan VAV Control, Multiple Zone System**:

During “ON” periods, ENABLE supply air fan volume control, as follows:

MONITOR supply air operating static pressure as AI point:

MONITOR supply air fan airflow rate (cfm) as AI point.

Modulate supply fan speed through VFD via AO point to maintain supply duct operating static pressure setpoint as follows:

Initial supply operating static pressure setpoint shall be set at 2.0" wg.

During TAB of air-handling system, adjust setpoint to value recommended by TAB subcontractor, as reviewed by A-E.

4.26 **"OFF" Period Space Temperature/Humidity Control, Multiple Zone System**:

During "OFF" periods, command air-handling system and exhaust fans associated with that air-handling system "OFF" via DO points.

MONITOR temperature and humidity in each zone served by the air-handling system.

If **any** space temperature exceeds the "OFF" period high limit temperature defined by Sequence 4.01 for 15 minutes, cooling shall be provided as follows:

If chilled water is not available, as indicated by the CHWS temperature being greater than 45°F after 15 minutes of operation, initiate alarm and terminate sequence.

If chilled water is available, as indicated by CHWS temperature being less than or equal to 45°F, command air-handling system and associated exhaust fans "ON" in accordance with Sequence 4.00.

Modulate cooling coil chilled water control valve 100% "OPEN" via AO point.

Terminal units served by air handling system shall operate in accordance with "ON" period sequence of operation defined for each terminal unit type to maintain space temperature at "OFF" period high limit temperature setpoint.

If **any** space temperature falls below the "OFF" period low limit temperature defined by Sequence 4.01 for 15 minutes, command the hot water system "ON" and provide heating as follows:

If hot water is not available, as indicated by the HWS temperature being less than 100°F after 15 minutes of operation, initiate alarm and terminate sequence.

If hot water is available, as indicated by the HWS temperature being equal to or greater than 100°F, command air-handling system and associated exhaust fans "ON" in accordance with Sequence 4.00:

Air handler shall operate according to "ON" period sequence of operation.

Terminal units served by air handling system shall operate in accordance with "ON" period sequence of operation defined for each terminal unit type to maintain space temperature at "OFF" period low limit temperature setpoint.

If **any** space humidity exceeds the high limit humidity setpoint, command hot water system and chilled water system "ON" and provide humidity control as follows:

If hot water is not available, as indicated by the HWS temperature being less than 100°F after 15 minutes of operation, initiate alarm and terminate sequence.

If chilled water is not available, as indicated by the CHWS temperature being greater than 45°F after 15 minutes of operation, initiate alarm and terminate sequence.

If both hot water, as indicated by the HWS temperature being equal to or greater than 100°F, **and** chilled water, as indicated by CHWS temperature being less than or equal to 45°F, are available, command air-handling system and associated exhaust fans "ON" in accordance with Sequence 4.00.

Modulate cooling coil chilled water control valve 100% "OPEN" via AO point to maintain all space humidity conditions at "OFF" period high limit setpoint.

Terminal units served by air handling system shall operate in accordance with “ON” period sequence of operation defined for each terminal unit type to maintain space temperature a “OFF” period high limit temperature setpoint**.**

If **any** space humidity falls below the low limit setpoint, command hot water system and chilled water system "ON" and provide humidity control as follows:

If hot water is not available, as indicated by the HWS temperature being less than 100°F after 15 minutes of operation, initiate alarm and terminate sequence.

If chilled water is not available, as indicated by the CHWS temperature being greater than 45°F after 15 minutes of operation, initiate alarm and terminate sequence.

If both hot water, as indicated by the HWS temperature being equal to or greater than 100°F, **and** chilled water, as indicated by CHWS temperature being less than or equal to 45°F, are available, command air-handling system and associated exhaust fans “ON” in accordance with Sequence 4.00.

Air handler shall operate according to “ON” period sequence of operation.

Terminal units served by air handling system shall operate in accordance with “ON” period sequence of operation defined for each terminal unit type to maintain space temperature a “OFF” period high limit temperature setpoint**.**

Once **all** space condition(s) return to within setpoint limit conditions, **+/- 2°F and/or +/-5% RH as defined above**, for 5 minutes, command the air-handling system and associated exhaust fans “OFF” via DO point, modulate both NO chilled water and NC heating coil hot water control valves “CLOSED” via AO points, DISABLE all terminal units, and command the chilled water system and hot water systems “OFF” via DO points.

4.27.3 **Terminal Unit, Single Duct, VAV Terminal Reheat, Single Maximum Airflow Setpoint**:

Terminal unit (TU) airflow setpoints (cfm) shall include the following, as applicable and as scheduled on the Drawings:

Vmax	Maximum TU airflow setpoint
Vmin	Minimum TU airflow setpoint

MONITOR each terminal unit NO primary airflow damper as AI point.

MONITOR each terminal unit discharge air temperature as AI point.

During scheduled “ON” periods defined by Sequence 1.14, TU shall operate as follows:

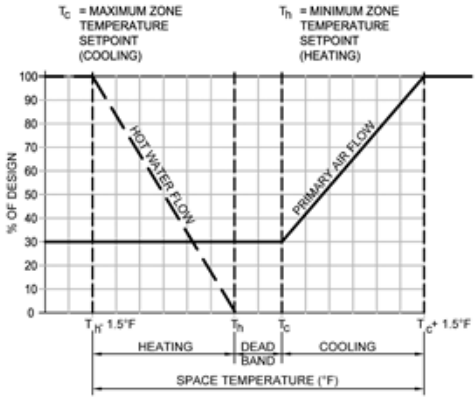
If space temperature rises above the maximum comfort zone temperature setpoint, modulate primary air volume damper via AO point between Vmin airflow setpoint and Vmax airflow setpoint to maintain space at maximum comfort zone temperature setpoint.

If space temperature falls below minimum comfort zone temperature setpoint, modulate primary air volume damper via AO point to maintain Vmin airflow setpoint and modulate heating control via AO point to maintain space at minimum comfort zone temperature setpoint.

Hot Water Heating Coil: Modulate NC hot water control valve to maintain space temperature at minimum comfort zone temperature setpoint.

When space temperature is within the comfort temperature zone, modulate the primary air volume damper to maintain Vmin airflow setpoint and modulate the heating hot water control valve closed.

"ON" period sequence of operation for terminal unit is illustrated by the following graphic:



During "OFF" periods, TU shall operate as follows:

When the air-handling system is "OFF," modulate the TU damper 100% "CLOSED" via AO point and DISABLE heating control.

If the space temperature exceeds the "OFF" period high temperature limit and the air-handling system and chilled water systems start in accordance with Sequence 4.26, TU shall provide cooling in accordance with its "ON" period cooling sequence above.

If the space temperature falls below the "OFF" period low temperature limit and the air-handling system and hot water systems start in accordance with Sequence 4.26, TU shall provide heating in accordance with its "ON" period heating sequence above.

If the space humidity exceeds the "OFF" period high humidity limit or falls below the "OFF" period low humidity limit and the air-handling system and both chilled and hot water systems start in accordance with Sequence 4.26, TU shall provide operate according to its "ON" period sequence.

4.3 Fan Coil Units

4.31 **Temperature Control**

Fan coil unit fan shall cycle on and off as required to maintain space temperature. Upon space temperature rising above setpoint fan coil unit shall be enabled and chilled water valve shall modulate to maintain space temperature. Upon space temperature falling back to within deadband fan shall be disabled and chilled water valve shall modulate closed to the coil. Upon space temperature falling below setpoint fan coil unit shall be enabled and hot water valve shall modulate to maintain space temperature. Upon space temperature rising back to within deadband fan shall be disabled and hot water valve shall modulate closed to the coil.

PACKAGED AIR-COOLED AND WATER-COOLED DX SYSTEMS

5.20 **Packaged Air-Cooled DX Unit, CAV Single Zone System (RTU-1):**

PRIMARY UNIT CONTROL IS PROVIDED BY OEM CONTROLLER INTERFACED WITH DDC SYSTEM.

See "Schedules" and "Details" drawing sheets and applicable specification sections that define the components and configuration of each air-handling system listed above.

Space temperature and humidity setpoints shall be in accordance with Sequence 4.01.

Factory Control Sequence

CAV System:

"ON" period control:

BAS shall start/stop the air handler based on occupancy schedule per sequence 4.00.

During occupied period unit shall run continuously in order to provide minimum outside air and modulate outside air damper to minimum outside air position as determined by TAB contractor.

On a rise in space temperature to above the maximum comfort zone temperature setpoint stage and modulate compressors to meet load.

On a fall in space temperature to below the minimum comfort zone temperature modulate heating to meet load.

Upon failure of heat pump to meet load emergency electric heat shall initiate and modulate to maintain setpoint until heat pump is able to resume operation.

On a rise in space humidity to above maximum “ON” humidity setpoint stage and modulate compressors to maintain humidity setpoint. Modulate hot gas reheat to maintain space temperature.

Dry bulb Economizer Control:

When the air-handling system is providing cooling, as evidenced by the space temperature being above the maximum comfort temperature setpoint, **and** the outdoor air temperature is at or below 55°F, stage compressors off and maintain space temperature at setpoint by modulating the outdoor air, return air, and relief air dampers.

When the air-handling system is providing cooling, as evidenced by the space temperature being above the maximum comfort temperature setpoint, **and** the outdoor temperature is above 55°F but at or below 65ºF modulate the outdoor air and relief air dampers 100% “OPEN” and return air damper 100% “CLOSED” via AO points so that the system operates with 100% outdoor air supply. Maintain the space temperature by modulating compressors.

When the outdoor air temperature is above 65ºF modulate the outdoor air damper to minimum and relief air damper 100% “CLOSED” and return air damper 100% “OPEN” so that the system operates with only minimum outdoor air supply.

During economizer mode relief air fan shall be enabled and modulated to maintain (+) 350 CFM.

"OFF" period control:

During “off” period operation the unit shall cycle to maintain “off” temperature setpoints as defined by sequence 4.01. During “off” period operation the return air damper shall go 100% open and the outside air damper shall be 0% open.

On a rise in space temperature to above the maximum “off” period zone temperature setpoint enable unit and stage and modulate compressors to meet load.

On a fall in space temperature to below the minimum comfort zone temperature enable unit and modulate heating to meet load.

Upon failure of heat pump emergency electric heat shall initiate and modulate to maintain setpoint until heat pump is able to resume operation.

On a rise in space humidity to above maximum “OFF” humidity setpoint enable unit and stage and modulate compressors to maintain humidity setpoint. Modulate hot gas reheat to maintain space temperature.

Dry bulb Economizer Control:

When the air-handling system is providing cooling, as evidenced by the space temperature being above the maximum comfort temperature setpoint, **and** the outdoor air temperature is at or below 55°F, stage compressors off and maintain space temperature at setpoint by modulating the outdoor air, return air, and relief air dampers.

When the air-handling system is providing cooling, as evidenced by the space temperature being above the maximum comfort temperature setpoint, **and** the outdoor temperature is above 55°F but at or below 65ºF modulate the outdoor air and relief air dampers 100% “OPEN” and return air damper 100% “CLOSED” via AO points so that the system operates with 100% outdoor air supply. Maintain the space temperature by modulating compressors

When the outdoor air temperature is above 65ºF modulate the outdoor air damper to minimum and relief air damper 100% “CLOSED” and return air damper 100% “OPEN” so that the system operates with only minimum outdoor air supply.

During economizer mode relief air fan shall be enabled and modulated to maintain (+) 350 CFM.

SPECIAL EXHAUST SYSTEMS

7.13 **Typical Conservation Space: Room Controls**:
Conservation Space: Room equipped with VAV fume hood(s), VAV snorkel(s), terminal reheat type terminal unit, and air valves. Refer to air balance drawings and floor plans for exact room configurations.

MONITOR terminal reheat unit supply airflow as AI point.

MONITOR each exhaust air valve exhaust airflow as AI point.

Snorkel VAV air valve shall modulate to the following airflows based on a 3-position switch: 100 CFM (Low), 300 CFM (Medium), 600 CFM (High).

Fume hood VAV air valve shall modulate via AO point to maintain exhaust airflow between minimum and maximum setpoints in direct response to AI point provided by the fume hood controller that monitors/controls hood face velocity at setpoint of 100 FPM.

Terminal unit airflow shall be the greater of (1) airflow required to satisfy space temperature and humidity setpoints or (2) airflow to track exhaust airflow and maintain a differential airflow setpoint between supply airflow and exhaust airflow. Hot water valve shall modulate to maintain space temperature setpoint.

If conservation space airflow offset flips, initiate alarm and increase snorkel/hood/room exhaust airflows to maintain total exhaust airflow (hoods + room + snorkels) at 110% of supply airflow. Refer to air balance plans for pressurization offsets.

7.14 **Conservation Workroom 258E: Room Controls**:
Conservation Space: Room equipped with VAV open face spray booth, VAV snorkel(s), VAV terminal reheat type air valve, and exhaust fans.

MONITOR terminal reheat unit supply airflow as AI point.

EF-1.1 serves the spray wall and shall be controlled via 3-position switch on wall. Switch position shall correspond to “Off”, 5,000 CFM (Medium), and 10,000 CFM (High) respectively. Fan shall be indexed to go to corresponding speed associated with switch position as determined by TAB. Upon fan switch indexing fan “On” motorized damper shall open and fan shall be enabled.

EF-1.2 serves as general exhaust for the room and will modulate based on states of the spray wall and snorkel switches. Fan shall be indexed to go to corresponding speed based on switch positions as determined by TAB. Upon fan switch indexing fan “On” motorized damper shall open and fan shall be enabled.

EF-1.4 shall be controlled via 3-position switch on wall. Switch positions shall correspond to “Off”, 300 CFM (Medium), and 600 CFM (High) respectively. Fan shall be indexed to go to corresponding speed based on switch positions as determined by TAB.

EF-1.5 shall be enabled by the BAS and run at constant volume.
Refer to table below for corresponding fan speeds based on switch position.

Equipment Switch		EF-1.1	EF-1.2	EF-1.3	EF-1.5
Snorkel	**Spray Wall**				
0 CFM	10,000 CFM	10,000 CFM	0 CFM	0 CFM	100 CFM
0 CFM	5,000 CFM	5,000 CFM	0 CFM	0 CFM	100 CFM
300 CFM	0 CFM	0 CFM	1600 CFM	300 CFM	100 CFM
600 CFM	0 CFM	0 CFM	1300 CFM	600 CFM	100 CFM
0 CFM	0 CFM	0 CFM	1900 CFM	0 CFM	100 CFM

Terminal unit airflow shall be the greater of (1) airflow required to satisfy space temperature and humidity setpoints or (2) airflow to track exhaust airflow and maintain a differential airflow setpoint between supply airflow and exhaust airflow. Refer to table above to calculate supply air valve required CFM to maintain offset based on fan states.

If space airflow offset flips, initiate alarm and increase snorkel/spray wall/room exhaust airflows to maintain total exhaust airflow (spray wall + room + snorkels) at 110% of supply airflow. Refer to air balance plans for pressurization offsets. Snorkel and spray wall exhaust fans shall not be permitted to run simultaneously. Upon switching calling for both to enable an alarm shall be generated. Spray wall shall take priority.

Supply air valve shall be tuned to gradually ramp up and down at the same rate as the paint spray exhaust fans to ensure no rapid pressurization changes resulting from fans being enabled and disabled.

Upon snorkel switch and spray wall switch being indexed on simultaneously and alarm shall be generated and the spray wall switch shall take priority. Snorkel and spray wall shall not be permitted to operate simultaneously.

In the event of a fire alarm EF-1.3 shall go to the minimum allowable speed.

Compressor Interlock: A separate current transducer shall be provided for the compressor interlock based on fan status. Upon EF-1.1 energizing the current transducer shall be made allowing power to go to the solenoid for the paint spray compressor. Solenoid shall be provided by Div. 22.

7.15 **Conservation: Fume Exhaust, VAV, Multi-Fan Manifold**:

Command exhaust fans "ON/OFF" via their VFDs in accordance with sequence 1.24 via DO points.

Lead/lag fan selection:

One exhaust fan shall be designated "lead" and one fan designated as "standby" for each exhaust fan system.

One exhaust fan shall operate and the second shall cycle “ON/OFF” as needed for each exhaust fan system.

Lead/standby fans selection shall be based on rotational sequence defined by sequence 1.26.1/1.26.2.

Start lead exhaust fan:

Confirm lead exhaust air flow on the basis of differential pressure flow via AI point.

If lead fan status DI point or differential pressure flow AI point indicates flow failure, terminate start sequence, initiate alarm, and initiate starting of next exhaust fan in the sequence.

Exhaust fan start/stop:

When starting any exhaust fan:

Command exhaust fan to start at minimum speed set in the VFD via DO point.

Command the isolation damper open.

If isolation damper end switch DI point does not indicate "DAMPER OPEN" condition within 2 minutes, command the exhaust fan “OFF” and the isolation damper closed, initiate alarm, and initiate starting of next exhaust fan in the sequence.

When stopping any exhaust fan:

Command isolation damper to close via AO point.

Ramp fan speed down to minimum at the same rate as the damper actuator stroke time via AO point.

After the fan is at minimum speed and the damper end switch indicates the damper is closed, command the fan "OFF" via DO point.

When switching lead fans or stopping a lag fan, prove operation of the new lead fan and allow 2 minutes for the fan to come up to speed before initiating the stop fan sequence.

Static pressure control:

Modulate exhaust fan VFDs and outside air bypass dampers via AO points in sequence to maintain static pressure setpoint as sensed by the static pressure sensors. Default static pressure setpoint is -3.0 in. wg. ***Final setpoint shall be determined during test and balance of the exhaust fans, as recommended by the TAB subcontractor and reviewed by the A-E***.

As exhaust airflow requirements decrease and the static pressure becomes more negative than setpoint, decrease the exhaust fans VFD speed to maintain the static pressure setpoint until the minimum fan flow setpoint is reached.

If the static pressure continues to fall, modulate open the outside air bypass dampers (in parallel, if more than one) to maintain the static pressure setpoint.

As exhaust airflow requirements increase and duct static pressure becomes less negative than setpoint, the fan shall continue to operate at their minimum fan flow setpoints and the outside air bypass dampers shall be modulated “CLOSED” via AO point to maintain duct static setpoint.

When the outside air bypass dampers are fully closed, the exhaust fans speed shall be increased to maintain static pressure at setpoint.

If the static sensors deviate by more than 0.05 in. wg, initiate alarm.

AIR-TO-AIR HEAT RECOVERY

8.10 **Run-Around Air-To-Air Heat Recovery**:

ENABLE/DISABLE heat recovery system on the basis of (1) user-defined "ON/OFF" schedule(s) of associated air-handling system(s) and exhaust air fan(s) when the outdoor air temperature is above 80ºF or below 55ºF or (2) operator command, as follows:

Heat recovery/outdoor air preconditioning control:

When heat recovery is ENABLED and the outdoor air temperature is below 55ºF, the outdoor air preconditioning coil(s) shall serve as the first stage of preheat:

Command heat recovery pump "ON" in accordance with Sequence 1.21.

Confirm pump operation based on motor status in accordance with Sequence 1.25.

Confirm heat recovery solution flow via differential pressure flow switch as DI point.

If pump or flow fails, command pump “OFF,” initiate alarm, and terminate sequence.

Modulate three-way control valve in direct response to AO point to maintain coil leaving air temperature at 50ºF setpoint.

If the heat recovery solution temperature entering the exhaust air falls to 30ºF, limit control loop output signal to three-way control valve via AO point to maintain entering solution temperature at 30ºF setpoint.

When heat recovery is ENABLED and the outdoor air temperature is above 80ºF, the outdoor air preconditioning coil(s) shall serve as to pre-cool entering outdoor:

Command heat recovery pump "ON" in accordance with Sequence 1.21.

Confirm pump operation based on motor status in accordance with Sequence 1.25.

Confirm heat recovery solution flow via differential pressure flow switch as DI point.

If pump or flow fails, command pump “OFF,” initiate alarm, and terminate sequence.

Modulate three-way control valve in direct response to AO point to maintain coil leaving air temperature at 80ºF setpoint.

END of Section 230993

SECTION 232113 – ABOVE GROUND HYDRONIC PIPING

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Fabricate and install hydronic piping in accordance with ASME B31.9, *Building Services Piping*.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data and installation instructions for water piping materials and products.

PART 2 - PRODUCTS

MATERIALS AND PRODUCTS

Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements.

PIPE AND PIPE FITTINGS

Piping Materials: Provide pipe and tube of type, joint type, grade, size and weight (wall thickness or Class) indicated for each service. Where type, grade or class is not indicated, provide proper selection as determined by Installer for installation requirements, and comply with governing regulations and industry standards.

Pipe/Tube Fittings: Provide factory-fabricated fittings of type, materials, grade, class and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve or equipment connection in each case. Where not otherwise indicated, comply with governing regulations and industry standards for selections, and with pipe manufacturer's recommendations where applicable.

STEEL PIPE AND PIPE FITTINGS

Carbon Steel Pipe: ASTM A53, Type E, Grade B for piping 2-1/2” NPS and larger or ASTM A53, Type F, Grade A for piping 2” NPS and smaller; plain or galvanized as indicated.

Cast-Iron Threaded Fittings: ANSI B16.4, plain or galvanized as indicated.

Malleable-Iron Threaded Fittings: ANSI B16.3, plain or galvanized as indicated.

Malleable-Iron Threaded Unions: ANSI B16.39, screwed, ANSI B1.20.1, Class 150 hexagonal stock with metal-to-metal bronze seats, plain or galvanized as indicated.

Threaded Pipe Plugs: ANSI B16.14, plain or galvanized as indicated.

Steel Flanges: Forged carbon steel, ASTM A105, slip-on type, 150 lb rating, plain, ANSI B16.9 raised face with 1/16" thick, non-asbestos ring type gasket, PTFE filled. Bolting shall be heavy hex head machine bolts or cap screws, ASTM A193-B7 steel alloy, with full nuts, ASTM A194- Gr. 2H steel alloy.

Carbon Steel Buttwelding Fittings: ASTM A234 Gr. WPB, seamless or welded, plain, ANSI B16.9, except ANSI B16.28 for short-radius elbows and returns, rated to match connected pipe.

Carbon Steel Flanged Fittings: ASME B16.5, 150 lb rating, plain or galvanized as indicated, with 1/16" thick, non-asbestos ring type gasket, PTFE filled. Bolting shall be heavy hex head machine bolts or cap screws, ASTM A193-B7 steel alloy, with full nuts, ASTM A194, Gr. 2H steel alloy.

Forged Steel Socket Weld Fittings: ASME B16.11, Class 2000, plain.

Forged Steel Branch Fittings (Weld-o-lets™, Thread-o-lets™, etc.): Comply with MSS SP-97, with thickness to meet pipe pressure ratings; plain

COPPER TUBE AND FITTINGS

Copper Tube: ASTM B 88, Type (wall thickness) as specified for each service, hard-drawn temper, solder joint except as otherwise indicated.

Copper Solder-Joint Fittings: Cast copper allow per ANSI B16.18 or wrought copper per ANSI B16.22, with "Type" to match adjacent piping, solder joint

Brass Pipe Flanges: ANSI B16.1, cast brass, with heavy head machine bolts or cap screws, ASTM A193-B7 steel alloy, with hex full nuts, Type 304 stainless steel per ASTM A194-Gr. 2H. Gasket shall be 1/8" natural rubber, 35-45 Durometer hardness.

Copper-Tube Unions: Provide unions with cast copper alloy body with ball-and-socket, metal-to-metal seating surfaces complying with MSS SP-123, solder joint.

PLASTIC PIPE AND PIPE FITTINGS

Polyvinyl Chloride (PVC) Drainage, Waste, and Vent Pipe and Fittings: PVC pipe and fittings shall be DWV type, UV-inhibited, and fabricated in accordance with ASTM D 1785. Fittings shall be socket type to match adjacent piping. Utilize primer complying with ASTM F 656 and solvent cement complying with ASTM D 2564 joints.

MISCELLANEOUS PIPING MATERIALS

Welding Materials: Except as otherwise indicated, provide welding materials to comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials.

Soldering Materials: Except as otherwise indicated, provide soldering materials as follows:

Tin-Antimony Solder: ASTM B 32, Grade 95TA
Silver-Lead Solder: ASTM B 32, Grade 96TS. **Use on potable water systems is prohibited.**

Brazing Filler Metals: AWS A5.8, Classification BAgl (silver)

Gaskets for Flanged Joints: Gasket material shall be full-faced for cast-iron flanges and raised-face for steel flanges. Select materials to suit the service of the piping system in which installed and which conform to their respective ANSI Standard (A21.11, B16.20, or B16.21). Provide materials that will not be detrimentally effected by the chemical and thermal conditions of the fluid being carried.

SPECIAL DUTY VALVES

Calibrated Plug Valves: 125 psig water working pressure, 250 deg F maximum operating temperature, bronze body, plug valve with calibrated orifice. Provide with connections for portable differential pressure meter with integral check valves and seals. Valve shall have integral pointer and calibrated scale to register degree of valve opening. Valves 2 inch and smaller shall have threaded connections and 2-1/2 inch valves shall have flanged connections.

Pressure Reducing Valves: Diaphragm operated, cast-iron or brass body valve, with low inlet pressure check valve, inlet strainer removable without system shut-down, and noncorrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory-set at operating pressure and have the capability for field adjustment.

Combined Pressure/Temperature Relief Valves: Diaphragm operated, cast-iron or brass body valve, with low inlet pressure check valve, inlet strainer removable without system shut-down, and noncorrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory-set at operating pressure and have the capability for field adjustment. Safety relief valve designed, manufactured, tested, and labeled in accordance with the requirements of Section IV of the ASME Boiler and Pressure Vessel Code. Valve body shall be cast-iron, with all wetted internal working parts made of brass and rubber, 125 psig working pressure and 250 deg F maximum operating temperature. Select valve to suit actual system pressure and Btu capacity. Provide with fast fill feature for filling hydronic system.

Spring-Loaded Pump Pressure Relief Valves: Spring operated, brass body valve actuated by inlet static pressure and designed to open to relieve excess pressure and to close to prevent further flow after inlet pressure falls below opening pressure setpoint. Valve shall have rapid opening/slow closing action. Valve shall be factory-set for opening pressure and flow scheduled on the Drawings and have the capability for field adjustment. Valve shall be Watson-McDaniel Model 10691, or equivalent.

HYDRONIC SPECIALTIES

Manual Air Vent: Bronze body and nonferrous internal parts, 150 psig working pressure, 225 deg F operating temperature, manually operated with screwdriver or thumbscrew, and having 1/8 inch discharge connection and 1/2 inch inlet connection. Nominal ½" ball valve may be used as manual air vent.

Y-Pattern Strainers: Class 150 cast-iron body, flanged ends for 2-1/2 inch and larger, threaded connections for 2 inch and smaller, bolted cover, Grade 18-8 stainless steel 20 mesh screen, and bottom drain connection.

Bladder-Type Expansion Tanks: Size and number as indicated, construct of welded carbon steel for 125 psig working pressure, 240 deg F maximum operating temperature. The tank shall be designed to absorb the expansion forces of heating/cooling system water while maintaining proper system pressurization under varying operating conditions. The bladder shall be replaceable and constructed of heavy duty Butyl rubber. Provide with pre-charged valve. Provide taps for system connection, air charging fitting (pre-charged valve), and drain fitting. Support vertical tanks with steel legs or base. Tank shall be fitted with lifting rings. Tank, with taps and supports, shall be constructed, tested, and labeled in accordance with ASME Pressure Vessel Code, Section VIII, Division 1.

Tangential Air Separator: Welded black steel construction complying with ASME *Boiler and Pressure Vessel Code*, Section VIII, Division 1, with a maximum working pressure of //125 psig//250 psig// at 270°F. Separator shall incorporate perforated stainless steel air collector tube designed to direct released air into compression tank, tangential inlet and outlet connections, screwed connections up to and including 2" NPS, flanged connections for 2-1/2" NPS and above, threaded vent connection, threaded blowdown connection, and be sized as indicated for full system flow capacity. A quarter-turn, full port ball valve at the bottom of the separator shall serve for manual blowdown of accumulated sediment. **Provide air separator without strainer.**

PART 3 - EXECUTION

PIPING APPLICATIONS

Hydronic systems pressure pipe shall be steel as hereinbefore specified, applied as follows:

Pipe Size 2" NPS and Smaller: Carbon steel pipe, black, Schedule 40, Class 125 black cast-iron fittings, with threaded joints.

Exceptions:

At the Contractor's option, socket weld fittings may be used in lieu of threaded fittings.

At the Contractor's option, copper tube may be utilized lieu of steel piping.

Pipe Size 2-1/2" NPS through 10" NPS: Carbon steel pipe, black, Schedule 40, steel buttwelding fittings with welded joints.

Copper Tube: Type L, hard-drawn temper, wrought-copper fittings with soldered joints, applied as follows:

Utilize copper tube for HVAC make-up water piping and condensate drain piping inside buildings. **Connect copper drain tubing to condensate drain pan nipples with dielectric unions.**

At the Contractor's option, pipe 2" NPS and smaller for any hydronic service may be copper.
PVC DWV Piping Size 4" NPS and Smaller: Schedule 40 pipe and drainage pattern fittings with solvent-welded joints shall be utilized for outdoor condensate drain piping.

VALVE APPLICATIONS

Provide valves complying with Section 230523, applied as follows:

Sectional Valves:

2" and Smaller: Gate or ball valves

2-1/2" and Larger: Butterfly valves

Shutoff Valves:

2" and Smaller: Gate or ball valves

2-1/2" and Larger: Butterfly valves

Drain Valves:

2" and Smaller: Gate valves or ball valves

Check Valves:

All Sizes: Swing or wafer check valves

Balancing Valves:

All Sizes: Plug valves, globe valves, butterfly valves, or calibrated balancing valves as indicated on the Drawings. Provide automatic balancing valves where indicated on the Drawings, with upstream Y-strainer.

INSTALLATION OF PIPING

Install eccentric reducers for horizontal piping where pipe is reduced in size in direction of flow, with tops of both pipes and reducer flush. Vertical piping use concentric reducers.

Reducers to be installed only where shown and at final connections to equipment. Install piping with 1/32" per foot (1/4%) to a point of drainage. Provide sufficient drains so that entire piping system can be emptied.

Connect branch-feed piping to mains at not more that 45-degrees above horizontal center line of mains, connect run-out piping to branches at not more that 45-degrees above horizontal center line of branches. **Connections above 45-degrees above horizontal center line or below the horizontal center line are prohibited.** Branch connections may be by forged steel branch fittings where branches are at least two pipe sizes smaller than the main.

Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.

Fabricate pipe nipples from same pipe as used for connected pipe. Use Schedule 80 pipe for nipple fabrication where unthreaded length is less than 1-1/2" or where pipe size is less than 1-1/2" NPS. **Do not thread nipples full length, "close" nipples are prohibited.**

Construct piping joints as follows:

Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

For screwed joints, thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

Construct welded joints in accordance with Section 019913.

For flanged Joints, select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.

INSTALLATION OF VALVES

Install sectional valves on each branch and riser, close to main, where branch or riser serves 2 or more hydronic terminals or equipment connections, and elsewhere as indicated.

Install shutoff valves on inlet and outlet of each mechanical equipment item and elsewhere as indicated.

Install drain valves on each mechanical equipment item located to completely drain equipment for service or repair. Install at base of each riser, at base of each rise or drop in piping system, and elsewhere where indicated or required to completely drain hydronic piping system.

Install gate or butterfly valve, with separate check valve, on discharge side of each pump. **The use of triple duty valves is prohibited.**

Install balancing valve on leaving side of each mechanical equipment item except for terminal unit coils, convectors, and radiators, as applicable.

Bronze valves larger than 2" NPS installed in steel piping systems shall be galvanic isolated with dialectic unions or flanges.

HYDRONIC SPECIALTIES INSTALLATION

Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

For closed hydronic systems, install bypass chemical feeders where indicated, in upright position with top of funnel not more than 48 inches above the floor. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections. Install NPS 3/4 pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.

EQUIPMENT CONNECTIONS

Arrange piping to minimize the need to dismantle piping to provide routine maintenance of equipment. Where piping must be dismantled, provide additional isolation valves and unions or flanges to facilitate its removal and replacement.

Connect piping to mechanical equipment as indicated on the Drawings, in compliance with the equipment manufacturer's instructions. Install shutoff valve on both supply and return connections and drain valve on each drain connection.
Install control valves in accessible locations close to connected equipment. Install valve with actuator on top and configure piping to provide adequate space for service and/or removal of operator.

Arrange and install vertical piping to not interfere with access for maintenance of HVAC equipment.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 232113

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

HI Compliance: Design, manufacture, and install HVAC pumps in accordance with Hydraulic Institute standards.

UL Compliance: Design, manufacture, and install HVAC pumps in accordance with UL 778, *Motor Operated Water Pumps*.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's pump specifications, installation and start-up instructions, and current accurate pump characteristic performance curves with selection points clearly indicated.

Variable Flow Pumps: The Pump PLEV efficiency based on AHRI Standard 550/590 “IPLV” load profile, 30% fixed head or calculated minimum control head, shall not be less than that of the pump specified. Submit a detailed pump efficiency report at each load point based on that load profile. AHRI Standard 550/590 “IPLV” equation, A, B, C, and D is the pump efficiency at 100%, 75%, 50%, 25% of design flow rate.

Performance: Include certified performance curves and rated capacities of selected models; shipping, installed, and operating weights; furnished specialties; and accessories for each type and size of pump specified. Indicate pumps’ operating point on curves.

PART 2 - PRODUCTS

GENERAL

Select pumps for operating point near the mid-range of the curve so the design capacity falls to the left of the best efficiency point.

Size pump motors to be non-overloading at any point on the head-capacity curve, including one pump operation in parallel or series pumping installation.

For variable flow pumps, pump operation shall be stable from essentially 0% to 100% of design flow with inverter duty pump coupling and motor.

Pump shaft couplings and coupling guards shall comply with the requirements of Section 019913.

CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

General: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically.

Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, replaceable bronze wear rings, and threaded or companion-flange connections, as applicable.

Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.

Pump Shaft: Stainless steel.

Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.

Exception: Use EPT in lieu of Buna-N where hydronic systems include glycol solutions.

Pump Bearings: Permanently lubricated ball bearings.

Motor: Single speed and rigidly mounted to pump casing, complying with the requirements of Section 230513.

SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

General: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.

Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections. Provide integral mount on volute to support the casing, and provide attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.

Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps not frequency-drive controlled, trim impeller to match specified performance.

Pump Shaft: Stainless steel.

Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.

Exception: Use EPT in lieu of Buna-N where hydronic systems include glycol solutions.

Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.

Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36 channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

Motor: Single speed complying with the requirements of Section 230513, secured to mounting frame, with adjustable alignment.

Pump Suction Diffuser: Cast-iron body, with threaded connections for 2 inch and smaller, flanged connections for 2-1/2 inch and larger; 175 psig working pressure, 250 deg F maximum operating temperature, and complete with the following features:

Inlet vanes with length 2-1/2 times pump suction diameter or greater.

Cylinder strainer with 3/16 inch diameter openings with total free area equal to or greater than 5 times cross-sectional area of pump suction, designed to withstand pressure differential equal to pump shutoff head.

Adjustable foot support, designed to carry weight of suction piping.

Blowdown tapping in bottom, gage tapping in side.

PART 3 - EXECUTION

PUMP INSTALLATION

Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

Install base-mounted pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases specified in Section 019913.

Install in-line pumps with continuous-thread hanger rods and spring hangers of size required to support weight of in-line pumps, in accordance with Section 230548.

Ensure that coupling guard is installed before starting pump.

ALIGNMENT

Comply with manufacturers' written instructions and the requirements in Hydronics Institute standards for alignment of pump and motor shaft of each separately-coupled base-mounted pump. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.

After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with non-shrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 232123

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

ANSI/ASME Compliance: Fabricate and install refrigerant piping in accordance with ANSI B31.5 *Refrigeration Piping and Heat Transfer Components.*

ASHRAE Compliance: Fabricate and install refrigerant piping in accordance with ASHRAE 15 *Safety Code for Refrigeration Systems.*

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data and installation instructions for refrigerant piping materials and products.

PART 2 - PRODUCTS

COPPER PIPING

Piping Materials: Provide pipe and tube of type, joint type, grade, size and weight (wall thickness or Class) indicated for each service. Where type, grade or class is not indicated, provide proper selection as determined by Installer for installation requirements, and comply with governing regulations and industry standards.

Size 1" and Larger: Utilize copper tube in compliance with ASTM B88, Type K, hard-drawn temper, wrought-copper, brazed-joint fittings, brazed joints.

Size 3/4" and Smaller: Utilize copper tube in compliance with ASTM B 280, Type ACR, soft annealed temper fittings, cast copper-alloy fittings for flared copper tubes; flared joints.

Brazed Joints: Brazed joints using brazing alloy in compliance with ASTM B32. Use silver brazing alloy.

COPPER FITTINGS

Pipe/Tube Fittings: Provide factory-fabricated fittings of type, materials, grade, class and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve or equipment connection in each case. Where not otherwise indicated, comply with governing regulations and industry standards for selections, and with pipe manufacturer's recommendations where applicable.

Copper Brazed-Joint Fittings: Cast copper per ANSI B16.18 or wrought copper per ANSI B16.22, with “type” to match adjacent piping.

Brass Pipe Flanges: ANSI B16.1, cast brass, with heavy head machine bolts or cap screws, ASTM A193-B7 steel alloy, with hex full nuts, Type 304 stainless steel per ASTM A194-Gr. 2H. Gasket shall be 1/8" natural rubber, 35-45 Durometer hardness.

Copper-Tube Unions: Provide standard products recommended by manufacturer for use in service indicated.

Piping Connectors for Dissimilar Non-Pressure Pipe: Elastomeric annular ring insert, or elastomeric flexible coupling secured at each end with stainless steel clamps, sized for exact fit to pipe ends and subject to approval by plumbing code.

REFRIGERANT VALVES

Service and Check Valves:

Service Shutoff Valves: Forged brass, packed, back seating, winged seal cap, 300 deg. F temperature rating, 500 psi working pressure.

Check Valves: Forged brass, accessible internal parts, soft synthetic seat, fully guided brass piston and stainless steel spring, 250 deg. F temperature rating, 500 psi working pressure.

Solenoid Valves:

2-Way Solenoid Valves: Forged brass, designed to conform to ARI 760 and UL 429, normally closed, teflon valve seat, NEMA 1 solenoid enclosure, 24 volt, 60 Hz., Listed, 1/2" conduit adapter, 250 deg. F temperature rating, 400 psi working pressure. Provide manual operator to open valve.

Safety Relief Valves: Comply with ASME *Boiler and Pressure Vessel Code*, Listed and Labeled. Valve construction and ratings shall be as follows:

Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.

Piston, Closing Spring, and Seat Insert: Stainless steel.

Seat Disc: Polytetrafluoroethylene.

End Connections: Threaded.

Working Pressure Rating: 400 psig.

Maximum Operating Temperature: 240 deg F.

Thermostatic Expansion Valves: Comply with ARI 750. Incorporate reverse-flow option for heat-pump applications. Valve construction and ratings shall be as follows:

Body, Bonnet, and Seal Cap: Forged brass or steel.

Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.

Packing and Gaskets: Non-asbestos.

Capillary and Bulb: Copper tubing filled with refrigerant charge.

Suction Temperature: 40 deg F.

Superheat: Adjustable.

Working Pressure Rating: 450 psig.

Hot-Gas Bypass Valves: Comply with UL 429. Valve construction and ratings shall be as follows:

Body, Bonnet, and Seal Cap: Ductile iron or steel.

Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.

Packing and Gaskets: Non-asbestos.

Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.

Seat: Polytetrafluoroethylene.

Equalizer: Internal.

Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter.

Throttling Range: Maximum 5 psig.

Working Pressure Rating: 500 psig.

Maximum Operating Temperature: 240 deg F.

REFRIGERANT SPECIALTIES

Refrigerant Strainers: Brass shell and end connections, brazed joints, monel screen, 100 mesh, Listed, 500 psig working pressure.

Moisture-Liquid Indicators: Forged brass, single port, removable cap, fused glass, 240 deg. F temperature rating, 500 psi working pressure.

Evaporator Pressure Regulators: Provide corrosion-resistant, spring loaded, stainless steel springs, pressure operated, evaporator pressure regulator, in size and working pressure indicated, with copper connections.

Refrigerant Discharge Line Mufflers: Provide discharge line mufflers as recommended by equipment manufacturer for use in service indicated.

Refrigerant Discharge Line Oil Separator: Separator shall be high efficiency centrifugal type designed for use with the type of refrigerant in the system, rated for at least 450 psig working pressure.

Replaceable-Core Filter Dryers: Provide filter dryers in compliance with ARI 730. Body and cover shall be painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets. Filter media shall be 10 micron, pleated with integral end rings; stainless-steel support. Working pressure rating of 500 psig and maximum operating temperature of 240 deg F.

Flexible Connectors: Connectors shall have stainless-steel bellows with woven, flexible, stainless-steel-wire-reinforced protective jacket. Connector shall be capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly. Factory test at minimum of 500 psig and maximum operating temperature of 250 deg F.

PART 3 - EXECUTION

PIPING INSTALLATION

Select system components with pressure rating equal to or greater than system operating pressure.

Install refrigerant piping according to ASHRAE 15, as follows:

Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

Install piping adjacent to machines to allow service and maintenance.

Install piping free of sags and bends.

Install fittings for changes in direction and branch connections.

Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection.

Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

Slope refrigerant piping as follows:

Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.

Install horizontal suction lines with a uniform slope downward to compressor.

Use double-suction riser for maximum compressor efficiencies if load variation is expected.

Install traps and double risers to entrain oil in vertical runs.

Liquid lines may be installed level.

When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

Protect refrigerant piping as follows:

Install underground refrigerant piping in protective PVC piping or conduit.

Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

PIPE JOINT CONSTRUCTION

Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

Construct solder joints according to ASTM B 828 or CDA's *Copper Tube Handbook*.

Construct brazed joints according to AWS's *Brazing Handbook*, Chapter "Pipe and Tube."

Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.

Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

For flanged joints, select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

VALVE AND SPECIALTY APPLICATIONS

Refrigerant valves and specialties shall be installed for each refrigerant system either as an original equipment manufacturer (OEM) installation or field-installed, as follows:

Install line-sized shutoff valves and flexible connectors in suction and discharge lines of each compressor.

Install line-sized shutoff valves on each side of other refrigeration equipment, including condensers, evaporators, receivers, etc. in multiple unit installations.

Install service valves for gage taps at strainers if they are not an integral part of strainers.

Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

Install filter dryers in liquid line between compressor and thermostatic expansion valve and in the suction line at each compressor, complete with full-sized three-valve bypass around filter dryers utilizing line-sized shutoff valves, so that filter dryer may be replaced while system remains in operation. Filter dryers shall be installed in the horizontal position, except that replaceable core filter dryers may be installed in the vertical position with the access flange on the bottom.

Install solenoid valves upstream from each expansion valve. Install solenoid valves in horizontal lines with operator at top.

Install thermostatic expansion valves as close as possible to distributors on evaporators. Install valve so diaphragm case is warmer than bulb. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Locate bulb on top of the suction line smaller than 2-1/8" OD and at the 4 o'clock or 8 o'clock position on larger lines. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

Where required by the compressor manufacturer, install discharge line oil separator on the discharge of each compressor, downstream of the flexible connector and/or discharge muffler, securely anchored to the unit. Oil return shall be connected to the compressor in accordance with manufacturer recommendations.

Install safety relief valves where required by ASME *Boiler and Pressure Vessel Code*. Pipe safety relief valve discharge line to outside according to ASHRAE Standard 15.

Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

Install strainers upstream from and adjacent to the following unless they are furnished as an integral OEM assembly for device being protected:

Solenoid valves

Expansion devices

Compressors

FIELD QUALITY CONTROL

Clean and test refrigerant piping in accordance with ANSI B31.5, Chapter VI. Perform initial test with dry nitrogen, using soap solution to test all joints. Perform final test with 27" vacuum, and then 200 psi using electronic leak detector. System must be entirely leak-free. **Submit leak test reports to A/E for review.**
Repair or replace refrigerant piping as required to eliminate leaks, and retest as specified to demonstrate compliance.

DEHYDRATION AND CHARGING SYSTEM

Install core in filter dryer after leak test but before evacuation.

Evacuate refrigerant system with vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.

Break vacuum with refrigerant gas, allow pressure to build up to 2 psig.

Complete charging of system, using new filter dryer core in charging line. Provide full operating charge.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 232300

SECTION 232513 – CLOSED HYDRONIC PIPING SYSTEMS WATER TREATMENT

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specifications sections, apply to the work of this section.

QUALITY ASSURANCE

Chemical feeding methods employed shall comply with all codes and regulations of authorities having jurisdiction.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data and installation instructions for water conditioning systems materials and products.

GENERAL

Water conditioning installations shall be as specified and indicated schematically on the Drawings. The installations shall be complete with all required equipment, material and appurtenances, whether or not specifically implied or expressed herein or indicated on the Drawings.

Electrical work shall be done in accordance with Section 230511.

Chemical feed and softened water piping and piping accessories shall be Schedule 80 CPVC in accordance with Section 232113.

Materials of construction of equipment furnished shall be suitable for the chemicals utilized.

Chemicals, feed and bleed equipment, and supervision for water conditioning programs shall be provided by a recognized water conditioning company with qualified laboratory and field service facilities readily available to the site. This company shall provide all chemicals, test kits and reagents required for the period of time hereinafter specified, including initial dosage and supervision and service for all phases of the water treatment program including the following:

Field supervision and certification of initial clean-out.

Field supervision for the installation and adjustment of automatic feed equipment and for the injection of initial dosages of treatment in all systems.

WATER TREATMENT PERFORMANCE CRITERIA

Water treatment for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment. The water treatment supplier shall design the water treatment program on the basis of the quality of water available at Project site, HVAC system equipment material characteristics and functional performance requirements, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
Closed hydronic systems shall be treated to have the following water qualities:

pH: Maintain a value within 9.0 to 10.5.

"P" Alkalinity: Maintain a value within 100 to 500 ppm.

Boron: Maintain a value within 100 to 200 ppm.
.
Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.

Soluble Copper: Maintain a maximum value of 0.20 ppm.

TDS: Maintain a maximum value of 10 ppm.

Ammonia: Maintain a maximum value of 20 ppm.

Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.

Microbiological Limits:

Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.

Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.

Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.

Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.

Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

Provide the initial chemical treatment for all systems based on a complete system fluid analysis prior to the equipment installation. The supply of chemical treatment materials for each system shall be adequate for the start-up and testing period until project final acceptance.

PART 2 - PRODUCTS

WATER TREATMENT CHEMICALS

Sequestering agent to reduce deposits and adjust pH shall be polyphosphate.

Corrosion inhibitors may be boron-nitrite, sodium nitrite and borax, sodium totyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.

Conductivity enhancers shall be phosphates or phosphonates.

TREATMENT EQUIPMENT

Bypass Feeder: 5 gallon minimum capacity, 125 psig working pressure, either a screw type cover or a valved funnel opening to feed chemical into the system, prime coat of paint.

FREEZE PROTECTION

To prevent freezing down to 0°F, energy recovery closed hydronic systems shall contain 32% (by volume) **corrosion-inhibited propylene glycol**. **Due to its higher toxicity levels, the use of ethylene glycol is prohibited. The use of automotive antifreeze is prohibited.**

Glycol concentration shall be maintained by a packaged glycol feed system including diaphragm pump and motor starter complying with Section 230511, pressure tank with pressure control, priming valve, pressure reducing valve, shut-off valves, and pressure gauge, connected to the glycol water system with a 1/2" NPT connection. Feed system shall include a controller that features a cut-off and alarm arrangement that will stop the pump in case of excessive pressure or a low solution level and activate an audible (which can be silenced) and a visual alarm. A 110V dry contact shall also be available for connection of alarm to the building control system.

Diaphragm pump shall be hydraulically-actuated, positive displacement pump rated for maximum 7 gpm flow rate at 100 psi discharge pressure. Capacity shall be adjustable from 0 to 100 percent of maximum flow by via micrometer dial while the pump is in operation. Pump motor shall be integrally-mounted 1/3 hp, 120/1/60, TENV motor with automatic thermal overload protection. Pump shall be activated by pressure-indicating switch.

Tank shall be polyethylene with structural steel support legs and hinged cover. Tank shall be provided with spill retention tops. Provide non-valved gage glass. Tank shall have 30-50 gallon capacity.

Accessories shall consist of hydraulically-actuated pressure relief valve, Type 316 stainless steel pump valves with cleaning cartridges, Type 316 stainless steel check valves, and cast-iron strainer with Type 304 stainless steel perforated basket. Piping shall be clear Teflon-reinforced PVC with compression fittings and joints.

PART 3 - EXECUTION

TREATMENT SYSTEMS INSTALLATION

Install a separate bypass type feeder at the pumps for the closed loop energy recovery system.

Provide a separate set of supply and return lines from each pump in the system and install ball valves in each of these lines.

Locate the system connection that supplies the feeder upstream of the discharge shutoff valve for the pump.

Locate the system connection that returns treatment back to the system at a convenient point downstream of the pump discharge shutoff valve.

Provide a drain valve at the bottom of the feeder.

TESTING

Sample systems with chemical treatment at one-week intervals after start-up for a period of 5 weeks and prepare certified test report for each required water performance characteristic. Comply with the following standards, as applicable:

ASTM D 859, *Tests for Silica in Water and Waste Water*
ASTM D 1067, *Tests for Acidity or Alkalinity of Water*
ASTM D 1068, *Tests for Iron in Water*
ASTM D 1126, *Tests for Hardness in Water*
ASTM D 1888, *Tests for Particulate and Dissolved Matter in Water*
ASTM D 3370, *Practices for Sampling Water*

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 232513

SECTION 233100 – HVAC DUCTWORK

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

NFPA Compliance:

Comply with NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*.

Comply with NFPA 90B, *Standard for the Installation of Warm Air Heating and Air Conditioning Systems*.

SMACNA Compliance: Fabricate and install all ductwork and ductwork accessories in accordance with *HVAC Duct Construction Standards - Metal and Flexible*.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data and installation instructions for ductwork and products.

PART 2 - PRODUCTS

DUCTWORK MATERIALS

Galvanized Sheet Metal: Except as indicated otherwise, fabricate ductwork from galvanized sheet steel complying with ASTM A 653, lockforming quality, with G 90 zinc coating in accordance with ASTM A 653 and mill phosphatized for exposed locations. Stamp gauge and manufacturer's identification on each sheet. Break sheets so that identification is exposed.

Stainless Steel Sheet: Exhaust duct runouts from main within conservation area serving fume hoods or snorkels shall be constructed of stainless steel complying with ASTM A 480, Type 304L or 316L with No. 4 finish where exposed to view in occupied spaces, No. 2D finish elsewhere. Longitudinal seams shall be continuously heliarc inert gas welded. Butt joints shall be made up with welded or Van Stone flanges and corrosion resistant gaskets. Elbows shall be minimum 5-gore sectional type and fittings with seams shall be welded and ground smooth on the inside. Protect finished surfaces with mill-applied adhesive protective paper, maintained through fabrication and installation.

Flexible Ducts: Metallic or non-metallic, insulated flexible ductwork complying with UL 181B. Provide 1" thick continuous flexible fiberglass sheath with vinyl vapor barrier jacket.

DUCT FABRICATION

Shop fabricate ductwork in 4, 8, 10 or 12-ft lengths, unless otherwise indicated. Preassemble work in shop to greatest extent possible, so as to minimize field assembly of systems. Disassemble systems only to extent necessary for shipping and handling. Match-mark sections for reassembly and coordinated installation.
Shop fabricate supply, return, and ventilation air ductwork of gauges and reinforcement complying with SMACNA's *HVAC Duct Construction Standards - Metal and Flexible*, **with the exception that sheet metal less than 24-ga. shall not be used for rectangular duct**, in accordance with the following:

Application	Construction Pressure Class
Return Ductwork	-2" W.G.
Supply Ductwork Downstream of Air Terminal Units	+1" W.G.
Supply Ductwork With Fan Static Pressure Less Than 2.5" W.G.	+2" W.G
Supply Ductwork with Fan Static Pressure Greater than or equal to 2.5" W.G.	+3" W.G
Supply Ductwork with Fan Static Pressure Greater than 5.0"W.G.	+4" W.G.
Conservation Exhaust Ductwork	-6" W.G.

Shop fabricate exhaust and relief ductwork of the following gauge sheet metal with reinforcement complying with SMACNA's *HVAC Duct Construction Standards - Metal and Flexible:*

Maximum Diameter or Maximum Rectangular Dimension (inches)	Sheet Metal Gauge
8	24
18	22
30	20
>30	18

Elbows/Tees:

Radius elbows and tees shall be fabricated as **full radius** elbows with the centerline radius 1.5 times the duct width.

Square throat elbows shall be constructed with double-wall airfoil turning vanes properly spaced for the duct width. Turning vanes and vane runners shall be constructed in accordance with SMACNA's *HVAC Duct Construction Standards - Metal and Flexible*, Figure 4-3. **Square throat elbows may be used only when the available space is insufficient for use of a full radius elbow**.

Perforated Metal Plenum Air Baffles: Construct of 50% free area perforated 304 stainless steel with angle iron supports and bracing to prevent bulging, rattling, etc. Metal thickness shall be as follows:

Fan Total Static Pressure	Gauge
Up to 4"	22
4" to 6"	20
Above 6"	18

ROUND AND OVAL DUCTWORK

Construction: Construct round and flat oval ductwork in accordance with Section 3 of SMACNA's *HVAC Duct Construction Standards - Metal and Flexible*, complying with the Pressure Class designations hereinbefore specified. Use spiral lockseam construction for ductwork up to 58" diameter and welded longitudinal seam for larger ductwork, 26 gauge minimum.

Exception: Round ducts that connect to air outlets or inlets may be constructed with a snaplock longitudinal seams complying with Fig. 3.2 of SMACNA's *HVAC Duct Construction Standards - Metal and Flexible,* 26 gauge minimum.

Double-Wall Ductwork: Round or flat oval ductwork shall be double walled where exposed to view. Construct with outer pressure shell, insulation layer, and perforated inner liner. Construct shell and liner of sheet metal as hereinbefore specified. Use spiral lockseam construction for ductwork up to 58" diameter and welded longitudinal seam for larger ductwork, in minimum gages listed, but not less than 24 gauge.

Inner Liner: Perforated sheet metal with holes for 23% open area. Provide metal spacers welded in position to maintain spacing and concentricity.

Insulation: Mineral fiber insulation complying with Section 230713, 2" thick. Cover insulation with polyester film complying with UL181, Class 1.

PART 3 - EXECUTION

INSTALLATION OF DUCTWORK

Assemble and install ductwork to achieve air-tight operation with no objectionable noise, capable of performing each indicated service. Install each run with minimum number of joints. Align ductwork accurately at connections, within 1/8" misalignment tolerance and with internal surfaces smooth.

Support ducts in accordance with Section 230529 to hold ducts true-to-shape and to prevent buckling. Support vertical ducts at every floor or roof penetration in accordance with Section 230529.

At ends of ducts that are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure fabricated of 6 mil PVC film or other covering that will prevent entrance of dust and debris until time connections are to be completed.

Routing:

Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs unless such routing is clearly indicated on the Drawings. Locate runs as indicated by diagrams, details and notations or, if not otherwise indicated, run ductwork in shortest route that does not obstruct useable space or block access for servicing building and its equipment. Coordinate layout with suspended ceiling, lighting, fire suppression systems, and similar finished work.

Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building. Unless indicated otherwise, install duct as high as possible.

Limit clearance to 1/2" where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork for 1" clearance outside of insulation.

Wherever possible in finished and occupied spaces, conceal ductwork from view by locating in mechanical shafts, hollow wall construction, or above ceilings.

Elbows: **Utilize radius elbows for all changes of direction unless specifically indicated otherwise on the drawings or space limitations dictate the use of square throat elbows with turning vanes**. Where square throat elbows with turning vanes are installed, provide a duct access door or panel immediately upstream of each elbow.
Sealing: Ductwork shall be sealed in accordance with SMACNA's *HVAC Duct Construction Standards - Metal and*

Flexible, as follows:

Duct Construction Class	Seal Class
+/- 1" W.G. or less	C
+/- 2" W.G.	B
+/- 3" W.G. and greater	A

Testing:

Ductwork indicated to be constructed in accordance with Pressure Class +/-3" W.G. or greater shall be tested, section by section, in accordance with SMACNA's HVAC *Air Duct Leakage Test Manual*. Air leakage factor (CL), computed in accordance with the following relationship, shall be less than or equal to 6.0:

$$CL = \text{Leakage rate (cfm/100 sf of duct surface)} \times (\text{Test static pressure})^{0.65}$$

Ductwork utilized as part of a smoke control system shall be tested, section by section, in accordance with SMACNA's HVAC *Air Duct Leakage Test Manual* and leakage shall not exceed 5% of design airflow.

INSTALLATION OF FLEXIBLE DUCTS

Flexible duct shall only be allowed where indicated on the drawings, installed as follows:

Install duct fully extended; do not install in the compressed state or use excess lengths.

Avoid bending ducts across sharp corners or incidental contact with metal fixtures, pipes or conduits. Radius at center line of bends shall not be less than one duct diameter.

All connections, joints and splices should be made in accordance with the manufacturer's installation instructions.

All tapes, mastics and non-metallic fasteners (plastic clamps) used for field installation of flexible ducts should be listed and labeled to UL 181B.

Sheet metal collars to which flexible ducts are attached should be a minimum of 2 inches in length and shall be beaded.

Sheet metal sleeves used for joining two sections of flexible duct should be a minimum of 4 inches in length and beaded on both ends.

Maximum Length: **Do not exceed 8'-0" extended length**.

Metal Duct Connection: Spin-in conical connectors with integral balancing damper shall be used for connecting flexible runouts to metal ductwork.

Ceiling Diffuser Connections: Connect flexible duct to supply air diffusers in accordance with SMACNA's *HVAC Duct Construction Standards - Metal and Flexible*, Figure 7-7, and as indicated on the Drawings.

ADJUSTING AND CLEANING

Clean ductwork internally, section by section, as it is installed, of dust and debris. Clean external surfaces of foreign substances that might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration. After cleaning, seal open ends and connections with 6 mil PVC film.

Strip protective paper from stainless ductwork surfaces, and repair finish wherever it has been damaged.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 233100

SECTION 233300 – AIR DUCT ACCESSORIES

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

UL Compliance:

Construct, test, and label fire dampers in accordance with UL Standard 555, *Standard for Fire Dampers*.

NFPA Compliance: Comply with applicable provisions of NFPA 90A and/or NFPA 90B pertaining to installation of ductwork accessories.

AMCA Compliance:

Test and rate airflow dampers in accordance with ANSI/AMCA Standard 500-D, *Laboratory Methods of Testing Dampers for Rating*.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data for each type of ductwork accessory, including dimensions, capacities, and materials of construction, and installation instructions. Provide specific instructions for installation of fire and smoke dampers to comply with listed installation arrangement.

Certified Data: Pressure drop and attenuation data for sound traps shall be submitted. Certification data shall be by a qualified independent laboratory. The test method shall be fully described. The certification of the data, both pressure drop and attenuation, shall be based upon tests of same trap for both measurements.

Samples: Submit louver manufacturer's standard colors for selection by A/E.

PART 2 - PRODUCTS

AIRFLOW DAMPERS

Low Pressure Manual (Balancing) Dampers:

Construction: Dampers installed in dishwasher exhaust ductwork and in other wet locations shall be constructed of Type 316 stainless steel, including shafts and hardware exposed to the airstream. All other dampers shall be constructed of G90 galvanized steel with zinc-plated shafts and hardware exposed to the airstream. Single blade or multiblade volume damper shall be constructed in accordance with SMACNA's *HVAC Duct Construction Standards - Metal and Flexible*, Figures 7-4 and 7-5.
Quadrant Locks: Provide each low pressure balancing damper with a quadrant lock device on one end of shaft, and end bearing plate on other end for damper lengths over 12". Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.

Control Dampers: Provide dampers with parallel blades for 2- position control, opposed blades for modulating control. Dampers shall be constructed of 0.108-inch-minimum thick steel or 0.125-inch-minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch-thick steel with maximum blade width of 8 inches and maximum length of 48 inches. Dampers installed in dishwasher exhaust ductwork, return air ductwork in natatoriums, and in other wet locations shall be constructed of Type 316 stainless steel, including shafts and damper hardware exposed to the airstream. All other dampers shall be constructed of G90 galvanized steel with zinc-plated shafts and hardware exposed to the airstream.

Secure blades to 1/2-inch-diameter axles with oil-impregnated sintered bronze blade bearings, blade-linkage hardware, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of each blade.

Operating Temperature Range: From minus 40 to plus 250° F.

Edge Seals: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for Leakage Class I according to ANSI/AMCA 500-D.

FIRE AND SMOKE DAMPERS

Construction: Dampers installed in dishwasher exhaust ductwork and in other wet locations shall be constructed of Type 316 stainless steel, including shafts and damper hardware exposed to the airstream. All other dampers shall be constructed of G90 galvanized steel with zinc-plated shafts and hardware exposed to the airstream.

Fire Dampers: Provide dynamic curtain type “A”, interlocking blade fire damper in accordance with UL-555. Provide heat responsive device rated at 165°F in duct systems with air temperatures up to 120° F and 212°F for air temperatures exceeding 120° F (i.e. smoke purge systems). Dampers installed in low velocity ductwork (1000 fpm or less) 12" or less in height or in high velocity ductwork shall be "Type B" damper (blades and frames out of the air stream), unless otherwise indicated on Drawings. Include blade lock and stainless steel closure spring for horizontal dampers.

Where dampers are installed behind sidewall supply or return grilles, the damper shall be fully serviceable through the grille.

DUCT ACCESS DOORS

Provide duct access doors where indicated on the Drawings or required by Division 23 specification sections, of size required for the application.

Provide access doors, whether indicated or not, for all duct mounted coils, fire damper or fire/smoke damper links, duct smoke detectors, and for visual access to all manual and automatic dampers. Unless indicated otherwise, doors shall be square, 2" less than smaller duct dimension, but not smaller than 12" by 12".

Fabricate access panels according to SMACNA's *HVAC Duct Construction Standards - Metal and Flexible*, Figures 7-2 and 7-3, as applicable, except that locks shall be cam type with steel or cast aluminum handles. **Plastic handles are prohibited.**

Doors shall be rectangular double-wall type, constructed of G90 galvanized sheet metal with mineral fiber insulation fill and thickness in accordance with Section 230713. Frame shall be galvanized sheet steel with bend-over tabs and foam gaskets.

Fabricate doors airtight and suitable for duct pressure class.

FLEXIBLE DUCT CONNECTORS

Provide flexible connector between ductwork and any fan or air-handling unit connected to the ductwork. Connectors shall be fabricated of noncombustible fabrics and any coatings or adhesives applied shall comply with UL 181, Class 1. Frame shall be steel and fabric shall be 26 oz/sq. yd or heavier. Connector shall be sized for minimum 50% additional travel and/or deflection at full airflow.

Where flexible connectors are located downstream of electric heating coils the connector shall be rated for application at temperatures up to 250°F.

SOUND ATTENUATORS

Sound attenuators shall be factory-fabricated type for rated for airflows, pressure drops, and acoustic performance indicated on the Drawings.

Casing shall be galvanized sheet metal of gauge equal to that required for ductwork of the same size and pressure class in accordance with Section 233100. Inner casing shall be perforated sheet metal, minimum 26 gauge. Seams shall be lock-formed and mastic-filled.

Provide inorganic, mineral fiber fill of sufficient density to obtain the specified acoustical performance, pre-packed to not less than 5% compression and vibration free. Fill shall have flame spread index of 25 or less and smoke developed index of 50 or less when tested in accordance with ASTM Standard E84.

Attenuators shall be acoustically rated as indicated on the Drawings with metal duct inlet and outlet sets under the rated airflow conditions measured by an independent laboratory in accordance with ASTM Standards E90 and E477. Noise reduction performance shall include the effects of flanking paths and vibration transmission.

PART 3 – EXECUTION

INSTALLATION

Install fire dampers in accordance with the manufacturer's installation requirements to comply with installation as UL-tested. Do not firestop the gap between the fire damper sleeve and the penetration unless specifically required by the damper manufacturer's installation instructions.

Locate duct access doors clear of obstructions and located for ready access to all ductwork accessories. Install duct access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter. Label access doors in accordance with Section 230553.
Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action.

Install sound attenuators in compliance with SMACNA's *HVAC Duct Construction Standards - Metal and Flexible*, as applicable. Provide flexible duct connector at both entering and leaving ends of attenuators.

EXTRA STOCK

Furnish extra fusible links to Owner, one link for every ten installed of each temperature range; obtain receipt.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 233300

SECTION 233416 – CENTRIFUGAL HVAC FANS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY CONTROL

AMCA Compliance:

Comply with AMCA performance requirements and bear the AMCA-Certified Ratings Seal.

Operating Limits: Classify according to AMCA 99.

Comply with AMCA 301, *Methods for Calculating Fan Sound Ratings from Laboratory Test Data*.

Factory test fans according to AMCA 300, *Reverberant Room Method for Sound Testing of Fans*.

Label fans with the AMCA-Certified Ratings Seal.

Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210/ASHRAE 51, *Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating*.

Acoustic Criteria: HVAC equipment shall be selected and installed to comply with the acoustic criteria defined in Section 230510.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data for fans, including specifications, capacity ratings, fan performance curves with operating point clearly indicated, gages and finishes of materials, dimensions, weights, accessories furnished, and installation instructions.

PART 2 - PRODUCTS

GENERAL

Fan Types: Fans requiring 5 horsepower motor size or less may be centrifugal type with forward curved blades. All fans exceeding 5 horsepower motor size shall be non-overloading centrifugal type with backward-inclined blades.

Coatings: Ferrous metal parts shall be factory prime coated and finish coated with baked enamel protective coating. Nonferrous and galvanized units and components shall not be factory coated. Where indicated, fans shall be provided with factory applied epoxy phenolic coating applied in multiple layers.

Sparkproof Fans: Fans indicated on the drawings or specs to be "spark-proof" shall be constructed with nonferrous, non-sparking wheels and shaft rubbing plate per AMCA "C.

FORWARD CURVED BLADE CENTRIFUGAL FANS

Description: Fans shall be Arrangement 3, direct drive centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.

Housings:

Formed panels to make curved-scroll housings with shaped cutoff.

Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.

Spun inlet cone with flange.

Outlet flange.

Forward-Curved Wheels:

Black-enameled or galvanized-steel construction with inlet flange, backplate, shallow blades with inlet and tip curved forward in direction of airflow.

Mechanically secured to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.

Shafts:

Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.

Turned, ground, and polished hot-rolled steel with keyway. Design to operate at no more than 70 percent of first critical speed at top of fan's speed range.

Bearings: Prelubricated and sealed shaft ball bearings, self-aligning, pillow-block-type life rated in accordance with ABMA 9, Ll0 at 100,000 hours.

BACKWARD INCLINED BLADE CENTRIFUGAL FANS

Description: Fans shall be Arrangement 3, belt driven, of class indicated on the Drawings.

Fan wheel shall have backward inclined airfoil pattern blades welded to a heavy gauge backplate and equipped with a heavy duty reinforced hub. Fan wheels shall be statically and dynamically balanced and shall be keyed to ground and polished steel shaft. Shaft and wheel shall be designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

Fan casing shall be heavy steel plate, reinforced with structural members, provided with angle iron duct collars, and inlet cones and shall be of all-welded construction.

Bolted and gasketed cleanout door required for fans with wheel diameter larger than 24 inches. Provide drain tapping and plug for all fans.

Bearings shall be grease-lubricated, self-aligning heavy duty ball bearings mounted in pillowblocks with dust seals and grease fittings and shall have rated life in accordance with AMBA 9, L10 of 100,000 hours.

Motor shall be mounted on adjustable slide rail base with fan and motor mounted on a common fabricated steel vibration base.

Belt Drives: Comply with requirements of Section 019913.

PLUG AND PLENUM FANS

Plug or plenum fans shall be backward-inclined, non-overloading centrifugal type as specified above, less an enclosing fan casing. Provide factory-assembled fan consisting of fan wheel, shaft, bearings, motor, belt drive, and open support structure for installation as indicated on the Drawings.

PART 3 - EXECUTION

INSTALLATION

Install fans level and plumb, supported in accordance with Section 230529.

Install units with clearances for service and maintenance.

FIELD QUALITY CONTROL

Perform the following tests and inspections with the assistance of a factory-authorized service representative:

Verify that shipping, blocking, and bracing are removed.

Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.

Verify that cleaning and adjusting are complete.

Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.

Adjust belt tension.

Verify lubrication for bearings and other moving parts.

Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.

Shut unit down and reconnect automatic temperature-control operators.

Remove and replace malfunctioning units and retest as specified above.

Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.

Prepare test and inspection reports.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 233416

SECTION 233423 – HVAC POWER VENTILATORS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY CONTROL

AMCA Compliance:

Comply with AMCA performance requirements and bear the AMCA-Certified Ratings Seal.

Operating Limits: Classify according to AMCA 99.

Comply with AMCA 301, *Methods for Calculating Fan Sound Ratings from Laboratory Test Data*.

Factory test fans according to AMCA 300, *Reverberant Room Method for Sound Testing of Fans*.

Label fans with the AMCA-Certified Ratings Seal.

Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210/ASHRAE 51, *Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating*.

UL Compliance: Power ventilators shall comply with UL 705.

Acoustic Criteria: HVAC equipment shall be selected and installed to comply with the acoustic criteria defined in Section 230510.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data for fans, including specifications, capacity ratings, fan performance curves with operating point clearly indicated, gages and finishes of materials, dimensions, weights, accessories furnished, and installation instructions.

PART 2 - PRODUCTS

GENERAL

Personnel safety screens shall be provided on fan suction and discharge openings except where fans are directly connected to ductwork, are in plenums, or openings are otherwise protected.

Ferrous metal parts shall be factory prime coated and finish coated with baked enamel protective coating. Nonferrous and galvanized units and components shall not be factory coated. Where indicated, fans shall be provided with factory applied epoxy phenolic coating applied in multiple layers.

POWER VENTILATORS

Inline Centrifugal Fans: Provide centrifugal inline, power ventilators of type, discharge arrangement, size, and capacity as indicated on the Drawings and as specified herein.

Type: Centrifugal fan, direct or belt driven as scheduled on the Drawings. Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or suspension mounting, as indicated on the Drawings.

Direct-Drive Units: Motor with variable speed controller mounted in airstream, factory wired to disconnect switch located on outside of fan housing, with wheel, inlet cone, and motor on swing-out service door.

Belt-Driven Units: Comply with requirements of Section 019913, including epoxy-coated steel cover. Motor shall be mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

Dampers: Provide motorized dampers, complying with the requirements of Section 233300.

Electrical:

Provide permanent split-capacitor type motor with variable speed controller for direct driven fans; capacitor-start, induction-run type motor for belt driven fans in accordance with Section 230513.

Provide factory-wired motor rated toggle or disconnect switch, as applicable, at motor in fan housing. Provide conduit chase within unit for electrical connection in accordance with Section 230511.

Utility Fans: Provide forward curved, centrifugal type, with housing field rotatable for discharge positions of type, size, roof curb, and capacity as scheduled, and as specified herein.

Fan casing shall be galvanized steel with belt guard, adjustable motor mount, suspension clips as required for mounting, and shall be of all-welded construction.

Fan wheels shall have steel blades and be statically and dynamically balanced and shall be keyed to ground and polished steel shafts.

Bearings shall be grease lubricated, self-aligning, heavy duty, ball type mounted in pillowblocks with dirt seals and with lubrication lines with grease fitting extended to housing exterior. Bearings shall have ABMA 9, L10 of 80,000 hours, rated life.

Weather Cover: Fan housing, including the motor and drive compartment shall be provided with protective covering for outdoor installation.

Dampers: Provide motorized dampers, complying with the requirements of Section 233300.

Spark Resistant Construction: Fans shall be constructed with Type B spark resistant construction in accordance with AMCA Standard 99-0401. Motors shall be located out of the airstream. The fan shall be constructed so that a shift of the wheel or shaft will not permit two ferrous parts of the fan to rub or strike. Parts of the fans in contract with the air stream shall be of nonferrous or non-sparking materials, or their casing shall be lined or constructed of such materials. Provide aluminum inlet cone and rub ring. Electrically ground all fan parts.

Electrical:

Provide permanent split-capacitor type motor for direct driven fans; capacitor-start, induction-run type motor for belt driven fans in accordance with Section 230513.

Provide factory-wired disconnect switch at motor in fan housing. Provide conduit chase within unit for electrical connection in accordance with Section 230511.

Stack:

Housing shall include discharge stack of same material as fan housing to increase the overall discharge height of the unit. Overall unit height with stack shall be 10 ft from roof deck.

Stack material to be a minimum of 18 gauge. Stack pressure drop shall be part of internal pressure drop of fan and shall not be part of the external static pressure. Stack discharge shall have tapered design increasing exit velocity.

Threaded drain connection with plug shall be located at lowest part of scroll housing to prevent moisture build-up in the interior of fan.

HIGH VOLUME LOW SPEED (HVLS) FANS

Provide high velocity, low speed fan suspended from building structure, size capacity, and arrangement as indicated on the Drawings and as specified herein.

The fan shall be ETL certified and built pursuant to construction guidelines set forth by UL standards 507 and CSA standard C22.2 No. 113-08. The fan shall be designed to move an effective amount of air for cooling and destratification, commercial applications. The fan, in operation, shall not disturb other hanging objects 2' (61 cm) outside of its circumference to a distance of 3' (91 cm) below its airfoils. The fan shall incorporate a direct drive system designed specifically for high volume, low speed fans to ensure silent operation. The sound levels from the fan operating at maximum speed shall not exceed 40 dBA (measured 20' (6.1 cm) below the blades and 20' (6.1 cm) horizontally from the center of the fan).

The fan shall be equipped with high volume, low speed airfoil blades of precision extruded aluminum alloy. Quantity as scheduled. Each airfoil shall be of the high performance. The airfoils shall be connected by means of two (2) sets of bolts and lock washers per airfoil. The airfoils shall be connected to the hub and interlocked with zinc plated steel retainers.

The fan shall be equipped with winglets designed to redirect outward airflow into downward airflow, thereby enhancing the efficiency and effectiveness of the fan. The winglets shall be molded thermoplastic polyester resin. A winglet shall be attached at the tip of each airfoil. Winglets shall be powder coated to match architects color sample.

An additional restraint shall be employed to secure each blade in the form of a nylon safety strap run interior to each blade and connected at the hub and the winglet.

The fan motor shall be a permanent magnet brushless motor rated for continuous operation at maximum speed with the capability of modulating the fan speed from 0-100% without the use of a gearbox or other mechanical means of control. The motor shall be a non-ventilated, heat sink design.

The fan hub shall be constructed of steel for high strength and durability. The hub shall be precision machined to achieve a well-balanced and solid rotating assembly. The hub shall incorporate five (5) safety retaining clips made of 1/8" (0.3 cm) thick steel that shall restrain the hub/airfoil assembly in case of shaft failure.

The fan mounting system shall be designed for quick and secure installation from the structure. All components in the mounting system shall be of welded construction using low carbon steel no less than 3/16" (0.5 cm) thick and powder coated or plated for corrosion resistance and appearance. All mounting bolts shall be SAE Grade 8 or equivalent.

The fan shall be equipped with a safety cable that provides an additional means of securing the fan assembly to the building structure. The safety cable shall be 3/16" (0.5 cm) diameter and fabricated out of 7 x 19 stranded galvanized steel. The loops shall be secured with swaged Nicopress fittings, pre-loaded and tested to 3,000 lb·f. Field construction of safety cables is not permitted.

The fan controller shall be incorporated into the fan assembly. The controller shall be factory programmed to minimize starting and braking torques. The controller shall be equipped with a simple diagnostic program and an LED light to identify and relay faults in the system. The controller shall be housed in an enclosure independent of the motor to prevent overheating or electrical interference.

The fan shall be equipped with a remote wall control with the ability to control multiple fans. The wall control shall be capable of mounting to a standard electrical box and shall include operator controls and display for controlling the fan's direction and speed. The controller shall be capable of controlling up to four fans. It shall provide diagnostics and fault history information for each of the connected fans. It shall have the ability to create up to four fan schedules. It shall be BACnet-compatible.
The manufacturer shall replace any products or components in accordance to the following schedule: Airfoils, Lifetime (Parts); Hub, Lifetime (Parts); Motor, 10 years (Parts); Controller, 10 years (Parts); and Labor, 1 year

PART 3 - EXECUTION

INSTALLATION OF FANS

Install power ventilators level and plumb in accordance with Section 230529.

Install units with clearances for service and maintenance.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 233423

SECTION 233450 – LABORATORY EXHAUST SYSTEM UTILIZING MIXED FLOW, HIGH PLUME EXHAUST FANS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Fans shall have been certified under AMCA 210, *Laboratory Methods of Testing Fans for Aerodynamic Performance for Rating***.**

Documented aspiration tests shall have been performed in conjunction with the fan performance test. Dilution rating shall be certified under AMCA 260, *Laboratory Methods of Testing Induced Flow Fans for Rating***.**

Sound testing shall be in accordance with AMCA 300, *Reverberant Room Method for Sound Testing of Fans.*

Fans shall be UL listed per UL 705 safety standard.

Fans shall meet the criteria of NFPA-45.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data for fans, including specifications, capacity ratings, fan performance curves with operating point clearly indicated, gages and finishes of materials, dimensions, weights, accessories furnished, and installation instructions.

Acceptable Exhaust Fan Manufacturers: Strobic Air Corporation, Greenheck, Cook.

PART 2 - PRODUCTS

FUME HOOD EXHAUST DUCTWORK

Chemical or Biohazard Fume Hood Exhaust Ductwork: Construct of galvanized sheet steel complying with ASTM A 527, lockforming quality, with G 90 zinc coating in accordance with ASTM A 525 and mill phosphatized for exposed locations, minimum 18 gauge. Longitudinal seams shall be continuously heliarc inert gas welded. Butt joints shall be made up with welded or Van Stone flanges and corrosion resistant gaskets. Elbows shall be minimum 5-gore sectional type and fittings with seams shall be welded and ground smooth on the inside.

FUME HOOD EXHAUST FANS

Exhaust fans shall be mixed-flow induced dilution, high plume discharge fans. Fans shall be direct driven in AMCA Arrangements 2 or AMCA Arrangement 4.

Minimum design airflow rates, static pressure, and plume heights shall be as indicated on the Drawings.

The scheduled minimum plume height shall be accomplished at the scheduled design airflow rate and analytically established from ASHRAE *Laboratory Design Guide*, Equation 9-2.

The plume height shall be visually indicated by inducing smoke at the fan inlet and also at the air inlet side of the induction ring.

The vertical plume height is determined and measured where the diluted smoke no longer continues a vertical path parallel with the centerline fan outlet or induction ring nozzle.

Fan performance ratings shall conform to AMCA Standard 211 and 311. Fans shall be tested in accordance with AMCA 210, 260 and 300 in an AMCA accredited laboratory and the fan shall be licensed to bear the AMCA seal for Certified Sound and Air Performance.

Construction:

Mixed flow impellers shall consist of combination axial/backward curved blades and shall be of welded steel construction. The impellers shall have non-stall and non-overloading performance characteristics with aerodynamically stable operation at any point on the fan curves.

Vibration isolation components shall comply with the requirements of Section 230548.

Fan and all drive components shall have a combined bearing life of up to L_{10} = 150,000 hours.

Stationary discharge guide vane sections shall be provided to increase fan efficiencies.

Fan shall be constructed to "spark resistant" Type C requirements as defined by AMCA 99, with a non-ferrous inlet bell provided in order to reduce sparking in the event of a motor bearing failure.

Fans shall be modular construction and capable of being assembled on the roof.

Chemical resistant gaskets shall be provided at all companion flanged joints.

Fasteners shall be Type 316 stainless steel.

A bolted access door shall be provided for impeller inspection on each fan.

Fans and accessories shall have internal drain systems to prevent rain water from entering exhaust duct system.

Fan assemblies shall be designed for mounting on conventional roof curb without the need for guy wire supports. Provide roof curb as detailed on the Drawings to support the fans/plenums.

Fan Discharge:

Discharges shall include twin FRP nozzles with passive third central stacks that are capable of generating aspiration. The FRP shall be chemically and UV resistant and designed to withstand cracking due to mechanical and air motion vibration.

Entrainment windbands shall provide secondary induction of outside air. Induction shall take place downstream of the fan impeller and shall not influence BHP or static pressure requirements. Windbands shall discharge up to 270% of the design flow rates. The manufacturer shall publish discharge volumes for all fans at specified primary exhaust flow.

Provide acoustical silencer nozzle as follows:

Nozzle shall be designed as an integral component of the exhaust fan discharge nozzle and shall not increase the height of the overall assembly.

Maximum air pressure drop shall be 0.1" W.G. when installed and all associated losses shall be included in the fan performance curve.

Silencer nozzle shall provide attenuation as required to meet the acoustic criteria specified in Section 230510. The published insertion loss values shall be obtained from an AMCA 300 test with the silencer installed on the fan specified.

The silencer shall be constructed with an outer shell of fiber reinforced plastic with a minimum of 3/16" wall thickness. The inner liner shall be perforated corrosion resistant steel. The silencer should be colored to match the fans. Acoustic media shall be 3lb. density fiberglass isolated from the air stream by a Tedlar film, non fibrous acoustical media.

Motors:

Motors shall be isolated from the primary exhaust air stream and shall be visible and accessible from the fan exterior for inspection and service.

Fan motors shall be Premium Efficient TEFC "Mill & Chemical" duty rated with a 1.15 service factor and an L_{10} bearing life of 150,000 hours, meeting the applicable requirements of Section 230513.

Motors shall have regreasable bearings with grease relief fittings in every NEMA frame. Extended lube lines shall be mounted to a bracket located on the fan housing with grease relief fittings on each line.

Fan motors shall be C-Face and foot mounted and shall be accessible and removable from outside the airstream.

Accessories:

Inlet mixing plenums shall be provided by the fan manufacturer. Each plenum shall be sized to support the weight and performance requirement of the number of fans listed on the schedule. Multiple fan plenums shall be insulated double wall construction with structural stiffeners. Double wall plenums shall have an overall minimum wall thickness of 1.5", and the insulation shall have a minimum R value of 4.34. Outer skin of double wall plenums shall be coated 12 Ga. Galvaneal steel. Inner skin shall be uncoated 18 Ga. Type 316 stainless steel. Multiple fan plenums shall be able to withstand a minimum of 12 in. w.g. of negative pressure. Single fan plenums shall be of continuously welded, heavy gauge steel construction. For single thickness plenums, coatings shall be the same as specified for the fans. All plenums shall be capable of supporting the fan(s) without guy wires or supports. The plenums shall include hinged access doors and safety screens over fan inlets. The primary air inlets shall be located on the bottom or side as noted on construction drawings. Unless otherwise specified, plenums shall be suitable for mounting on roof curbs.

Safety screens shall be supplied over inlet of fan.

Bypass dampers shall be provided with all mixing plenums for outside air with primary exhaust. Dampers will be opposed blade low leakage air foil control dampers with extended shaft for connection to an operator. The dampers shall be all aluminum or steel construction. Rain hoods shall be provided with each damper.

Low leakage isolation dampers shall be constructed of aluminum or steel air foil extrusions. Operators shall be 2 position, spring return. Electric operators shall be factory wired (via a transformer when required) to the fan disconnect switch to open when the fan is energized and close via a spring return when de-energized. When the fan ships separate from the plenum, all wiring and conduit shall be factory supplied for easy connection in the field.

All dampers shall be rated for maximum static of system as indicated on the Drawings.

Vortex breakers shall be provided on all side inlet and multiple fan plenums.

Provide factory-wired disconnect switch at motor in fan housing. Provide conduit chase within unit for electrical connection in accordance with Section 230511.

Performance verification:

Each assembled fan shall be test run at the factory at the specified fan rpm with CFM per watt and vibration signatures shall be recorded and documented. Vibration signatures are to be measured at each bearing location in the horizontal, vertical, and axial planes. The maximum allowable fan vibration shall not be greater than 0.08 inches per second at the peak velocity; filter-in reading as measured at the fan rpm. The report with documented test results shall be included with the shipment for each fan.
Fan dynamic balance not to exceed 0.5 mil, peak-to-peak for nominal 900 RPM, 1200 RPM, and 1800 RPM fans, or 0.055 in/sec peak for 1800 RPM, 0.035 in/sec, peak for 1200 RPM, and 0.030 in/sec peak for 900 RPM fans, measured at the blade pass area when operating at fan frequency.

Extended Warranty: **The fan manufacturer shall provide a 7 year warranty from time of purchase to include fan, motor and drive elements**.

CORROSION RESISTANT COATING

All exhaust fans and system components (fan, nozzle, windband, plenum, dampers, etc.) shall be corrosion resistant coated.

Prior to coating, components shall be cleaned to SSPC SP10 (Near-White Blast Cleaning) standards and painted with a zinc rich epoxy primer (no less than 70% zinc).

Corrosion resistant coating as indicated on the Drawings shall be applied. The coating system shall not be less than a total thickness of 6 mils and shall not affected by the UV component of sunlight. Coating shall exceed 4000 hour rating in accordance with ASTM B117 *Salt Spray Resistance*.

PART 3 - EXECUTION

INSTALLATION OF EXHAUST SYSTEMS

Installation of laboratory exhaust systems shall comply with ANSI Z9.5, *Laboratory Design,* and the ASHRAE *Laboratory Design Guide.*

Exhaust ductwork shall be installed with supports and reinforcement required by the SMACNA *Round Industrial Duct Construction Standards.*

Install chemical or biohazard fume hood exhaust ductwork with minimum 1/8" per foot slope toward the hood.

Exhaust ductwork shall be sealed to Seal Class A in accordance with of SMACNA's *HVAC Duct Construction Standards - Metal and Flexible.*

Exhaust ductwork shall be tested, section by section in accordance with SMACNA's HVAC *Air Duct Leakage Test Manual* and shall have zero leakage.

Exhaust systems (and supplemental make-up air systems, as applicable) shall be balanced as specified in Section 230593. Fume hood performance then shall be tested utilizing a manikin and tracer gas in strict accordance with ASHRAE *Standard 110* with the fume hood sash at the 100%, 50%, and 25% open positions and certified test results submitted to the A/E.

FIELD QUALITY CONTROL

Perform the following tests and inspections with the assistance of a factory-authorized service representative:

Verify that shipping, blocking, and bracing are removed.

Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.

Verify that cleaning and adjusting are complete.

Verify fan wheel free rotation and smooth bearing operation.

Verify lubrication for bearings and other moving parts.

Energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.

Remove and replace malfunctioning units and retest as specified above.

Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.

Prepare test and inspection reports.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 233450

SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE:

NFPA Compliance: Construct air terminals using acoustical and thermal insulations complying with NFPA 90A.

ARI Compliance: Air terminals shall be tested, rated, and certified in accordance with AHRI Standard 880.

Flame/Smoke Ratings: Provide composite insulation/liners (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 225) method.

Acoustic Criteria: HVAC equipment shall be selected and installed to comply with the acoustic criteria defined in Section 230510.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturers Data: Submit manufacturer's technical product data, including performance data for each size and type of air terminal furnished, schedule showing drawing designation, number furnished, model number, size, and accessories furnished.

Samples: A sample of each type and size of terminal unit shall be provided at A/E's request.

PART 2 - PRODUCTS

GENERAL REQUIREMENTS

General: Primary air terminal devices shall be provided as indicated on the Drawings.

The type of device, capacity rating, and control type and arrangement shall be as scheduled Drawings. Units shall be selected to obtain sound levels defined in Section 230510.

Casings: Casing shall be constructed of minimum 20 ga. aluminum or steel, reinforced to SMACNA Standards for +4" W.G. duct construction. All seams and joints shall be continuously mechanically sealed by welding, Pittsburgh locks, drives, or equivalent and sealed in accordance with SMACNA's *HVAC Duct Construction Standards - Metal and Flexible* for +4" W.G. duct construction. **Pop rivets, punch connections, and/or sheet metal screw joint connections are not acceptable.** Leakage shall not exceed 2% with air pressure to +4" W.G. inside casing.

An access door must be located between primary damper and hot water coil to allow inspection of damper and cleaning of coil.

Casing Liner: Enclosures shall be internally insulated with minimum 1" thickness of elastomeric closed cell foam insulation. Insulation shall conform to UL 181 for erosion and NFPA 90A for fire, smoke and melting, and comply with a 25/50 Flame Spread and Smoke Developed Index per ASTM E-84 or UL 723. Additionally, insulation shall comply with Antimicrobial Performance Rating of 0, no observed growth, per ASTM G-21.

Air Flow Sensor: Air flow sensor shall be of a cross configuration located at the inlet of the assembly. The sensor shall have multiple total pressure sensing ports and a center averaging chamber designed to accurately average the flow across the inlet of the assembly. Sensor shall provide accuracy within 10% of full range. Provide external capped test ports on both total pressure and static pressure tubes to enable testing the airflow without having to remove pressure lines to the controller.

Terminal Unit Control Elements: The air terminal unit manufacturer shall mount, wire, and/or pipe all terminal unit controls. **The following controls shall be furnished by the HVAC control systems subcontractor and shipped to the terminal unit manufacturer's factory for installation:**

Damper actuator

Terminal unit controller

The following controls shall be furnished and installed by the air terminal unit manufacturer:

Transformer

Relays

Pitot tube array

The air terminal unit manufacturer shall coordinate with the HVAC control systems subcontractor relative to mounting details, wiring diagrams, control sequences, and shipping arrangements to ensure that properly configured air terminal units arrive at the project in a timely manner. The air terminal unit manufacturer shall install control devices in accordance with the HVAC controls systems subcontractor's instructions.

ABOVE CEILING AIR TERMINAL UNITS

VAV/Reheat Unit: Pressure independent single duct variable volume minimum position heating type shall be designed for operation between a preset maximum and a preset minimum air flow rate and shall be furnished with a minimum position heating coil, a variable flow regulator with an integral operator to position regulator from preset maximum to preset minimum air flow in response to signal from the controlling instrument and shall maintain the required flow regardless of variation in inlet static pressure, and a constant volume regulator to maintain the preset minimum air flow regardless of variations in inlet static pressure. The unit shall be guaranteed to maintain the air volumes indicated at maximum and minimum flow within plus or minus 5% with inlet static pressures varying from 3/4 inch to 4" w.g.

Heating coil shall be as indicated on the Drawings and shall comply with requirements of Section 238216. Provide access panel in unit upstream coil.

Constant Volume Reheat Unit: Pressure independent single duct constant volume heating type shall be designed to maintain a constant air flow regardless of variation in inlet static pressure, and shall be furnished with a heating coil and a self-adjusting constant volume regulator to maintain the preset air flow. The unit shall maintain the air volume indicated within plus or minus 5% with inlet static pressures varying from 3/4 inch to 4 inches w.g..

Heating coil shall be as indicated on the Drawings and shall comply with the requirements of Section 238216. Provide access panel in unit upstream of coil.

PART 3 – EXECUTION

ABOVE CEILING AIR TERMINAL UNITS INSTALLATION

Locate units as indicated on the Drawings, taking care that units are located only above lay-in or otherwise accessible ceilings and where there is sufficient clearance from piping, raceway, and ductwork for the unit to be maintainable.

Install level and plumb and support in strict accordance with the manufacturer's requirements and in accordance with Section 230529.

Locate units generally in accordance with the drawings, but ensure that access to the units is not blocked by light fixtures, piping, ductwork, etc.

Provide not more than 6'-0" length of flexible supply duct the same diameter as the unit connection. Avoid tight turns, offsets, kinks, etc. in the supply duct and **arrange supply duct so there is at least 24" straight duct upstream of the unit pitot tube assembly**.

Provide flexible duct connector on unit discharge in accordance with Section 230529.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 233600

SECTION 233650 – LABORATORY VENTURI AIRFLOW CONTROL VALVES

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE:

ARI Compliance: Air terminals shall be tested, rated, and certified in accordance with ARI Standard 880.

Acoustic Criteria: HVAC equipment shall be selected and installed to comply with the acoustic criteria defined in Section 230510.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturers Data: Submit manufacturer's technical product data, including performance data for each size and type of air terminal furnished, schedule showing drawing designation, number furnished, model number, size, and accessories furnished.

Samples: A sample of each type and size of airflow control valves shall be provided at A/E's request.

PART 2 - PRODUCTS

GENERAL REQUIREMENTS

Venturi airflow control valves shall be provided as indicated on the Drawings.

The type of device, capacity rating, and control type and arrangement shall be as indicated on the Drawings. Units shall be selected to obtain sound levels defined in Section 230510.

VENTURI AIRFLOW CONTROL VALVES

Venturi valves shall be pressure independent over a 0.6 in. to 3.0 in. static pressure operating range. An integral pressure independent assembly shall respond and maintain specific air flow irrespective of the magnitude of pressure and/or flow change or quantity of Venturi valves on a manifolded system. The Venturi valve shall maintain accuracy within ±5% of signal over an air flow turndown range of no less than 16 to 1.

Response time to change in command signal and duct static pressure shall be three seconds or less.

Provide aluminum construction for non-fume hood and non-corrosive applications. Construct with 16 gauge spun aluminum valve body and control device with continuous welded seam and Type 316 stainless steel shaft and shaft support brackets. Pressure independent springs shall be stainless steel. Shaft bearing surfaces shall be Teflon or polyester.

Provide stainless steel valve body and valve with phenolic coating, equivalent to Heresite P403, for fume hood applications. Construct with Type 316 stainless steel continuous welded seam valve body, control device, shaft, shaft support bracket, pivot arm and internal mounting link. The control device shall have a baked on corrosion resistant phenolic coating. The shaft shall have a Teflon coating and all shaft bearing surfaces shall be made of Teflon. The pressure independent springs shall be made of stainless steel.

Where indicated, the airflow device shall have no exposed aluminum or stainless steel components. The shaft support brackets, pivot arm, internal mounting link, and pressure independent springs shall have a baked-on corrosion resistant phenolic coating. Internal nuts, bolts, and rivets shall be titanium or phenolic coated stainless steel.

Provide air control valves as indicated on the Drawings, with rated capacities as scheduled. Valves shall include the following:

Actuator factory-mounted to the valve.

Integral factory-mounted controller to provide closed loop control of airflow by way of flow feedback signal with less than 1 second response time.

Shaft shall be positioned using direct potentiometer measurement to produce a linear factory calibrated feedback.

Airflow Valve Controller: Manufacturer-furnished, factory-installed unit controls, including final control elements, shall meet the requirements of the control I/O points and sequences of operation shown on the Drawings. **Unit controllers shall interface seamlessly with the direct digital control (DDC) system specified in Sections 230913 and 230923, fully complying with the operational requirements for "Control Units" specified in Section 230923**.

Certification:

Control device: factory calibrated to airflows detailed on plans using NIST traceable air stations and instrumentation having a combined accuracy of plus or minus 1% of signal over the entire range of measurement.

Electronic airflow control devices shall be factory calibrated and their accuracy verified to plus or minus 5% of signal at a minimum of eight different airflows across the full operating range of the device.

All airflow control devices: individually marked with device specific, factory calibration data to include: tag number, serial number, model number, eight point characterization information (for electronic devices), and quality control inspection numbers.

PART 3 – EXECUTION

INSTALLATION

Venturi air valves shall be installed as indicated on the Drawings in strict accordance with the manufacturer's installation instructions and recommendations.

Locate units as indicated on the Drawings, taking care that units are located only above lay-in or otherwise accessible ceilings and where there is sufficient clearance from piping, raceway, and ductwork for the unit to be maintainable. Locate units generally in accordance with the drawings, but ensure that access to the units is not blocked by light fixtures, piping, ductwork, etc.

Install level and plumb in strict accordance with the manufacturer's requirements and support units in accordance with Section 230529.

Provide flexible duct connector in accordance with Section 230529 on both the upstream and downstream ends of each air valve. **The use of flexible duct is prohibited.**

Support valves rigidly so they remain stationary at all times. Cross-bracing or other means of stiffening shall be provided as necessary. Method of support shall be such that distortion and malfunction of units cannot occur.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 233650

SECTION 233713 - DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

ARI Compliance: Test and rate air outlets and inlets in accordance with ARI 650, *Standard for Air Outlets and Inlets*.

ASHRAE Compliance: Test and rate air outlets and inlets in accordance with ASHRAE 70, *Method of Testing for Rating the Air Flow Performance of Outlets and Inlets*.

NFPA Compliance: Install air outlets and inlets in accordance with NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*.

ASTM Compliance: Paint hardness shall pass 125 hour ASTM B 117 salt spray test, 500 hour ASTM D-870 water impression test, and ASTM D-2794 reverse impact cracking test with a 50 in/lb force applied.

Acoustic Criteria: HVAC equipment shall be selected and installed to comply with the acoustic criteria defined in Section 230510.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data for air outlets and inlets including the following:

Schedule of air outlets and inlets indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.

Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details.

Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses, throw and drop, and noise criteria ratings. Indicate selections on data.

Samples: Samples of each unit proposed shall be submitted for review upon request by A-E.

PART 2 - PRODUCTS

REGISTERS, GRILLES AND DIFFUSERS

General: Diffusers, registers, and grilles for supply, return, and exhaust air shall be provided as indicated on the Drawings. Units shall be selected for noise levels required by Section 230510, with "draftless" distribution (terminal air velocity 50 fpm or less). Units that are noisy in the opinion of the A-E, shall be removed and replaced with acceptable ones. Performance based on volume controls fully opened.

Units shall be furnished with gaskets at edges to prevent leakage.

The interior portions of wall grilles and registers, including connecting duct, which are exposed to view, shall be painted flat black. Interior portion of ceiling diffusers shall be of the same color as the diffusers and accessories shall be flat black.

Manufacturer's model numbers specified herein are intended for ease of identification and comparison. Equivalent products by manufacturers other than those listed, equal in appearance and performance, may be acceptable upon review by A/E.

Unless indicated otherwise on the Drawings, all registers, grilles, and diffusers shall be steel construction.

Exception: Registers, grilles, and diffusers located in kitchens and restrooms shall be aluminum construction.

Rectangular Louvered Face Ceiling Diffuser **(Type-B)**: Louvered full face diffuser with round neck that is adjustable horizontal to vertical, constructed of 24 gauge steel or aluminum, as indicated on the Drawings, and finished with baked white enamel unless otherwise noted. Frame style shall match ceiling types(s). Diffuser shall be as follows:

Manufacturer	Steel Construction Model No.	Aluminum Construction Model No.
Titus	TMSA	TMSA-AA
Tuttle & Bailey	1300A	A1300A
Price	SCDA	ASCDA
Nailor	RNSA	ARNSA

Plenum Slot Diffusers **(Type-D)**: Plenum slot diffusers with insulated sheet metal plenum, number and width of slots as scheduled or required to meet performance criteria (minimum of 2 slots), lengths as scheduled or indicated in plan, adjustable pattern controllers, constructed of heavy gauge aluminum and finished baked white enamel unless otherwise indicated. Frame style shall match ceiling type(s). Provide opposed blade damper in duct. Diffuser shall be Titus model ML-Series, Tuttle & Bailey model APPS or ITPS, Price SDS series, Nailor 5800 series, or equivalent.

Standard Blade Sidewall Supply Register and/or Grille **(Type-F)**: Supply register and/or grille that is adjustable double deflection type with horizontal front blades, constructed of 20 gauge steel, 0.05”thick aluminum, or 20 gauge Type 316 stainless steel as indicated on the drawings and finished baked white enamel unless otherwise noted. Blades shall be spaced 5/8” – 3/4" apart. Frame style shall match surface type(s). Register or grille shall be as follows:

Manufacturer	Steel Construction Model No.	Aluminum Construction Model No.
Titus	300 RL	300FL
Tuttle & Bailey	T54	A54
Price	520	620
Nailor	61DH	51DH

Round Louvered Face Ceiling Diffuser **(Type-K)**: Louvered full face diffuser that is adjustable horizontal to vertical, constructed of 18 gauge steel or 0.05" thick aluminum as indicated on the Drawings and finished with baked white enamel unless otherwise noted. Diffuser shall be as follows:

Manufacturer	Steel Construction Model No.
Titus	TMRA
Tuttle & Bailey	VJR
Price	RCD
Nailor	RNR

Linear Bar Diffuser **(Type-L)**: Linear bar diffuser with 1/8" aluminum bars at 1/2" spacing or be "pencil proof" as indicated on the Drawings with frame constructed of aluminum, and finished bake white enamel for ceiling and wall diffusers and an anodized finish for floor and sill diffusers unless otherwise indicated. Bars shall have a 0-degree or 15-degree deflection, as indicated. Wall and ceiling diffusers shall have a one piece removable core and frame style to match surface type. Floor and sill diffusers shall be foot traffic rated and have concealed screw fastening frame. Diffuser shall be as follows:

Manufacturer	1/2" Bar Spacing Model No.	Pencil Proof Bar Spacing Model No.
Titus	CT580	CTPP0
Tuttle & Bailey	T-Series	-
Price	LBP158/LBMH15B/16B	LBPH/LBMH25C/26C
Nailor	49-Series	49-Series

Linear Bar Register and/or Grille **(Type-T)**: Linear bar register and/or grille with 1/8" aluminum bars at 1/2" spacing or "pencil proof" spacing as indicated on the Drawings with frame constructed of aluminum, and finished bake white enamel for ceilings and walls and anodized for floors and sills unless otherwise indicated. Bars shall have a 0-degree or 15-degree deflection as indicated. Wall and ceiling registers and/or grilles shall have a one piece removable core and frame style to match surface type. Floor and sill registers and/or grilles shall be foot traffic rated and have concealed screw fastening frame. Register shall be as follows:

Manufacturer	1/2" Bar Spacing Model No.	Pencil Proof Bar Spacing Model No.
Titus	CT580	CTPP0
Tuttle & Bailey	T-Series	-
Price	LBP158	LBP25C
Nailor	49-Series	49-Series

Standard Blade Sidewall Return or Exhaust Register and/or Grille **(Type-V)**: Return and exhaust register and/or grille that is single deflection type with fixed horizontal blades at 35-40 degrees, constructed of 20 gauge steel, 0.05" thick aluminum, or 20 gauge Type 316 stainless steel as indicated on the Drawings and finished baked white enamel unless otherwise noted. Blades shall be spaced 5/8" – 3/4" apart. Frame style shall match surface type(s). Register and/or grille shall be as follows:

Manufacturer	Steel Construction Model No.	Aluminum Construction Model No.
Titus	350RL	350FL
Tuttle & Bailey	T70D	A70D
Price	530	630
Nailor	6145H	5145H

Perforated Face Register or Grille **(Type-Z)**: Perforated panel face diffuser with adjustable louver vanes, hinged flush face, backpan and interior painted flat black. Register/grille shall be constructed of 26 gauge steel or aluminum as indicated on the Drawings and finished baked white enamel unless otherwise noted. Frame style shall match ceiling type(s). Register or grille shall be as follows:

Manufacturer	Steel Construction Model No.	Aluminum Construction Model No.
Titus	PAR	PAR-AA
Tuttle & Bailey	PG	APG
Price	PDDR	APDDR
Nailor	4360	4360AA

PART 3 - EXECUTION

INSTALLATION

Locate ceiling air diffusers, registers, and grilles as indicated on general construction "Reflected Ceiling Plans." Unless otherwise indicated, locate units in center of acoustical ceiling modules. Locate floor grilles where indicated on the Drawings.

Install diffusers, registers, and grilles in full accordance with the manufacturer's recommendations. **Modifications in ductwork, accessories, and arrangement from that indicated on the Drawings, but required for integration of the diffusers, registers and grilles proposed into the system as designed shall be the responsibility of the Contractor.**

Unless indicated otherwise on the Drawings, registers, grilles, and diffusers shall be provided with balancing dampers located at the branch duct connection, not at the air distribution device. Where a balancing damper is indicated at the register, grille, or diffuser, it shall be a rectangular opposed blade damper for installation in square or rectangular necks or a radial opposed blade damper for installation in round necks. **The use of butterfly dampers or horizontal radial dampers at air distribution devices is prohibited.**

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 233713

SECTION 234113 - PARTICULATE AIR FILTRATION, LOW EFFICIENCY (MERV 6-8)

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Product Data: For each type of product indicated. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

QUALITY ASSURANCE

Particulate filters shall have Minimum Efficiency Rating Value (MERV) specified herein when tested in accordance with ASHRAE 52.2

Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

Filters shall comply with the requirements of NFPA 90A and NFPA 90B.

PART 2 - PRODUCTS

PLEATED PANEL FILTERS

Description: Factory-fabricated, 1" or 2” thick as indicated on the Drawings, self-supported, extended-surface, pleated, panel-type, disposable air filters with holding frames with MERV rating of 6-8 and thickness as indicated on the Drawings.

Smoke and Flammability Limits: UL 900, Class 1.

Media: Interlaced glass or synthetic fibers coated with nonflammable adhesive.

Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

Media shall be coated with an antimicrobial agent.

Separators shall be bonded to the media to maintain pleat configuration.

Welded wire grid shall be on downstream side to maintain pleat.

Media shall be bonded to frame to prevent air bypass.

Support members on upstream and downstream sides to maintain pleat spacing.

Filter-Media Frame: Cardboard frame with perforated metal retainer sealed or bonded to the media.

Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.

Capacities and Characteristics: Rated airflow, size, and pressure losses shall be as indicated on the Drawings.

PART 3 - EXECUTION

INSTALLATION

Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.

Install filters in position to prevent passage of unfiltered air.

Do not operate fan system until filters are in place. Replace filters used during construction and testing with new, clean filters prior to final acceptance.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 234113

SECTION 234123 - PARTICULATE AIR FILTRATION, MEDIUM EFFICIENCY (MERV 9-16)

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Product Data: For each type of product indicated. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

QUALITY ASSURANCE

Particulate filters shall have Minimum Efficiency Rating Value (MERV) specified herein when tested in accordance with ASHRAE 52.2

Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

Filters shall comply with the requirements of NFPA 90A and NFPA 90B.

PART 2 - PRODUCTS

PLEATED PANEL FILTERS

Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters with holding frames and with MERV rating of 9-16 and thickness as indicated on the Drawings.

Smoke And Flammability Limits: UL 900, Class 1.

Media: Interlaced glass or synthetic fibers coated with nonflammable adhesive.

Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

Media shall be coated with an antimicrobial agent.

Separators shall be bonded to the media to maintain pleat configuration.

Welded wire grid shall be on downstream side to maintain pleat.

Media shall be bonded to frame to prevent air bypass.

Support members on upstream and downstream sides to maintain pleat spacing.

Filter-Media Frame: Cardboard frame with perforated metal retainer sealed or bonded to the media.

Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.

Capacities and Characteristics: Rated airflow, size, and pressure losses shall be as indicated on the Drawings.

SIDE-SERVICE FILTER HOUSINGS

Description: Factory-assembled, side-service housings, constructed of galvanized steel with flanges to connect to duct or casing system.

Prefilters: Where indicated on the Drawings, incorporate integral tracks to accommodate 2-inch pleated media filters with MERV 9 efficiency.

Access Doors: Hinged, with continuous gaskets on perimeter and positive-locking devices, and arranged so filter cartridges can be loaded from either access door.

Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames and to prevent bypass of unfiltered air.

FILTER GAGES

Diaphragm-type gage with 4-1/2 inch diameter dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment. Gage scale range shall be as follows:

Manufacturer Recommended Final Filter Resistance (inches wg)	Gage Range (inches wg)
Less than 2	0-2
2-3	0-3
3-4	0-4
4 or greater	0-10

Provide static-pressure tips, tubing, gage connections, and mounting bracket for duct or AHU installation as required.

Gage shall include manual set high pressure setpoint and incorporate integral Form C relay (DPDT switch) for connection to facility DDC system to indicate that filter replacement is required. Gage shall be Dwyer Series A3000 Photohelic, or equivalent, differential pressure switch/gage.

PART 3 - EXECUTION

INSTALLATION

Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.

Install filters in position to prevent passage of unfiltered air.

Install filter gage for each filter bank.

Do not operate fan system until filters are in place. Replace filters used during construction and testing with new, clean filters prior to final acceptance.

Install filter-gage, static-pressure taps upstream and downstream from filters. Install filter gages on filter banks with separate static-pressure taps upstream and downstream from filters. Mount filter gages on outside of filter housing or filter plenum in an accessible position.

Coordinate filter installations with duct and air-handling-unit installations.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 234123

SECTION 234213 – ULTRAVIOLET GERMICIDAL IRRADIATION (UVGI) SYSTEM

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

UL Compliance:

UVGI system components shall be constructed to withstand typical HVAC environments and be ETL listed under UL Standard 1598.

UVGI system shall comply with UL 1995 for use in HVAC equipment and shall carry the UL label.

International Ultraviolet Association (IUVA) Compliance:

Comply with IUVA G01A, *General Guideline for Air and Surface Disinfection Systems*.

Comply with IUVA G02A, *Guideline for Design and Installation of UVGI Air Disinfection Systems in New Building Construction*.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's specifications showing dimensions, capacities, ratings, performance characteristics, gages and finishes of materials and installation instructions for each manufactured component.

Disinfection Performance Model: Submit computer-based model to illustrate system performance and disinfection effectiveness.

PART 2 - PRODUCTS

UVGI LAMPS AND LAMP ARRAY

Lamps: Lamps and ballasts shall the following characteristics:

Emit UVC radiation, at least 85% of which is emitted at 253.7 nm wavelength.

Withstand typical HVAC environments and be ETL listed under UL Standard 1598.

Be certified as non-generators of ozone.

Have rated lamp life of at 9000 hours.

Lamp Array: Quantity and arrangement of UVGI lamps shall be determined by the manufacturer to satisfy the following performance requirements:

Produce constant and uniform irradiation dose for the application, resulting in at least a 90% disinfection effect for vegetative bacteria, mycobacteria, bacterial spores, and fungal spores, computed in accordance with Equation 1, Page 16.2, 2008 ASHRAE Handbook - *HVAC Systems and Equipment.*

For surface disinfection applications, UVGI effectiveness shall be demonstrated through computer-based performance modeling that incorporates the following factors:

Type of lamps and power supply.
Lamp dimensions.
Surface height and width.
Distance between lamp centerline and surface.
Cooling coil depth.
Air velocity.
Air temperature.
Biocontaminants and their sensitivity to UVC radiation.
Lamp cooling effect due to air velocity and temperature.
Lamp fouling.
Lamp age.

System: Provide UVC lamps, reflectors, controls, wiring, and supporting framework to form a complete UVGI system.

Disconnect: Provide manual, lockable disconnecting switch in accordance with Section 230511, located on the outside of the AHU, to de-energize the UVGI system by authorized personnel.

Performance Monitor: Provide UV radiometer, permanently installed, to measure UV radiation output of lamps and provide an audible and visual alarm when the radiation level falls to a preset level. Provide a dry contact for connection to building control system provided under Sections 230913 and 230923.

COOLING COIL AND DRAIN PAN DISINFECTION

Locate UVGI lamp array not more than 4 feet upstream of cooling coil and drain pans, arranged to provide uniform irradiation dose over the entire surface area of the cooling coil and drain pans.

UVGI system shall operate at all times, regardless of AHU operation. UV lights shall be hard-wire inter-locked with doors to access section such that if doors are opened UV lights are disabled.

PART 3 - EXECUTION

INSTALLATION

The UVGI system shall be installed in strict accordance with manufacturer's requirements.

Electrical connections shall be in accordance with Section 230511.

SAFETY REQUIREMENTS

Install safety interlock switches, with manual reset, on **each** air-handling unit access door or panel, interlocked to de-energize the UVGI system if any access door or panel is opened.

Install 12" wide x 6" high sign, with black letters on a yellow background, on **each** air-handling unit access door or panel, as follows:

CAUTION!
Ultraviolet Energy in Air-Handling Unit Do Not Switch Off Safety Interlock or Activate Lamps While Unit is Occupied

Test UVGI system radiation levels upon completion of installation using a UV radiometer directly facing the lamp(s) at eye level at several locations within the application area. If test levels exceed 6000 $\mu J/cm^2$, the system must be de-energized and adjusted to reduce radiation levels to below this value.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 234213

SECTION 235543 – UNFIRED UNIT HEATERS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

ARI Compliance: Test and rate cabinet unit heaters in accordance with ARI Standard 440, *Room Fan-Coil Air Conditioners*.

UL Compliance: Construct and install unit heaters in compliance with UL 883, *Safety Standards for Fan Coil Units and Room Fan Heater Units*.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's specifications for terminal units showing dimensions, capacities, ratings, performance characteristics, gages and finishes of materials, and installation instructions.

PART 2 – PRODUCTS

UNIT HEATERS

General: Provide suspended electric unit heaters as indicated on the Drawings of capacities, style, and having accessories as scheduled on the Drawings.

CEILING MOUNTED HEATERS

Backbox: Construct backbox of 20-gauge steel with knockouts for field wiring.

Inner Frame Assembly: Inner frame assembly shall be of 20-gauge steel on which are mounted the heating element, fan, motor, and blade, fan control, and thermal cutout. The inner frame assembly shall be completely wired.

Heating element: The heating element shall be of non-glowing design in a steel sheath.

Motor and Controls: The fan motor shall be impedance protected, permanently lubricated and totally enclosed rotor. Fan control shall be bimetallic, snap action type and shall activate after heating element reaches operating temperature and continue to operate the fan after the thermostat is satisfied and until all heat has been discharged. Thermal cutout shall be bimetallic, snap action type designed to shut off heater in the event of overheating and reactivate the heater when temperatures return to normal.

Disconnect Switch: A factory installed disconnect switch shall be provided for positive disconnect of power supply. It shall be completely sealed behind the front cover.

Thermostat: Unit shall be provided with integral thermostat for control. Thermostat shall be hydraulic snap action type with sensing bulb in return airstream.

Front Cover: The louvered front cover shall be of commercial grade steel finished in White baked enamel.

Finish: All sheet metal parts, except the front cover and galvanized back shall be phosphatized, then completely painted by a baked enamel process.

CABINET UNIT HEATERS

General: Provide surface-mounted cabinet unit heaters, as indicated on the Drawings, of capacities, style, and having accessories as scheduled. Include unit chassis, heating coil, removable fan and motor board, and insulation.

Chassis: Galvanized steel wrap-around structural frame.

Insulation: 1" thick rigid mineral fiber in accordance with ASTM C612.

Cabinet: Provide cabinet constructed of 14-ga steel removable panels with baked enamel finish in manufacturer's standard color selected by the A/E. Cabinet face shall incorporate integral discharge and intake grilles.

Coils: Electric as indicated on the Drawings, shall comply with the requirements of Section 238216.

Fan and Motor Board: Provide removable fan and motor board as follows:

Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.

Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements of Section 230513.

Wiring Termination: Connect motor to chassis wiring with plug connection.

Thermostat: Unit shall be provided with integral thermostat for control. Thermostat shall be hydraulic snap action type with sensing bulb in return airstream.

Disconnect Switch: A factory installed disconnect switch shall be provided for positive disconnect of power supply. It shall be completely sealed behind the front cover.

PART 3 – EXECUTION

INSTALLATION OF CABINET UNIT HEATERS

Install cabinet heaters as indicated, and in accordance with manufacturer's installation instructions.

Locate cabinet heaters as indicated. Provide correctly sized wall recess for recessed units.

ADJUSTING AND CLEANING

After construction is completed, including painting, clean unit exposed surfaces, vacuum clean terminal coils and inside of cabinets.

Retouch any marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 235543

SECTION 237314 – CUSTOM AIR-HANDLING UNITS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

Air handling unit components shall meet the specific requirements of the following Specification sections:

Component	Section
Electrical service	230511
Motors	230513
Drives	019913/230514
Fans	233416
Coils	238216
Support/Vibration Control	230529/230548/233300
Filters	234113/234123
Dampers	233300
UVGI Systems	234213
Humidifiers	238413

QUALITY ASSURANCE

AMCA Compliance: Test and rate air handling units in accordance with AMCA standards.

AHRI Compliance: Test and rate air handling units in accordance with AHRI 430, *Standard for Central-Station Air Handling Units*.

Acoustic Criteria: HVAC equipment shall be selected and installed to comply with the acoustic criteria defined in Section 230510.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data for air handling units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, gages and finishes of materials, and installation instructions.

Sound Criteria Calculations: The equipment manufacturer shall furnish calculations showing the estimated sound power levels at the supply and return connections, as well as unit casing radiation for each air handling unit. Calculations shall be based on fan sound power levels determined in accordance with AMCA Standards 300 and 301. Calculations must document that the unit will satisfy the noise criteria defined in Section 230510.

PART 2 - PRODUCTS

DESCRIPTION

Air-handling units (AHUs) shall be custom-fabricated and factory-assembled on a common structural base. AHU type, components, capacities, and arrangement of sections shall be as indicated on the Drawings.

AHU STRUCTURAL FRAME

Each AHU base shall be constructed with minimum 6" high welded steel or aluminum channel base and cross members. Base shall have removable lifting lugs located and sized to allow rigging and handling of the unit.

Units constructed in multiple sections shall be engineered for field assembly and testing. Provide full length perimeter angles located inside units at section splits to allow for field bolting of modular sections. The mating upper frame of each section shall be fabricated with a flanged perimeter. The flanged perimeter shall be drilled with assembly clearance holes and be continuously gasketed. Assembly lugs, fabricated from structural steel with appropriate assembly clearance holes, shall be bolted to the base frame.

AHU CASINGS

General: Casings, including walls, floors, and roof, shall be double-wall type, constructed and assembled to be watertight and with minimal air leakage as hereinafter specified. Floors and walls shall be designed so that deflection is limited to no more than 1/200 of span dimension at unit operating pressures.

Wall Casing Construction:

Outside Panel: Minimum 16 gauge G90 galvanized sheet metal with outer panel finish specified below.

Inside Panel: Minimum 18 gauge G235 galvanized sheet metal. aluminum alloy, or stainless steel, as indicated on the Drawings. Where indicated, inside panels shall be perforated.

Outer Panel Finish: Immediately after cleaning and pre-treating, apply manufacturer's standard color two-coat, baked-on enamel finish, consisting of prime coat and thermosetting topcoat.

Floor Construction:

Floors shall be minimum 10 gauge galvanized sheet metal, aluminum alloy, or stainless steel to match wall casings. For "walk-in" units, floors shall have raised tread plate surface.

Floor insulation shall be covered with external aluminum alloy sheet, minimum 0.032" thickness.

Casing and Floor Insulation: Provide insulation meeting one of the following criteria, minimum 3" thick for wall casing and 2" thick for floors:

Fiberglass insulation, ASTM C612, Class I, unfaced securely mounted between inside and outside panels of casings.

Foam insulation, spray polyurethane cellular plastic foam, complying with the following:

Core Density (ASTM D1622): Minimum 2 pcf.

Thermal Resistance (ASTM C518): Minimum R6.0/inch (140ºF, 90 day aged R-value, measured at 75ºF mean temperature).

Compressive Strength (ASTM D1621, 10% parallel to rise): Minimum 20 psi

Closed Cell Content (ASTM D2856): Minimum 95 percent.

Water Absorption by Volume maximum. (ASTM D2842): 2.5 percent.

Water Vapor Permeability maximum. (ASTM E96): 2.5 perm-inches.

Condensate Drain Pans:

Condensate drain pans shall extend throughout the cooling coil, humidifier, and fan sections of the AHU (as applicable).

Fabricate pans of 12 gauge Type 304 stainless steel, 2" thick double wall insulated construction, minimum 2 inches deep, with minimum 2% slope in at least three planes to collect condensate from cooling coils (including uninsulated coil piping connections, coil headers, and return bends) and/or water from humdifiers.

Locate drain connection(s) at lowest point of pan on both ends of pan, sized to prevent overflow, minimum 2" NPS. Terminate with threaded galvanized pipe nipple.

AHUs with stacked cooling coils shall have an intermediate drain pan and drain piping at each coil level to collect condensate from upper coils.

Air Tightness: Unit air leakage shall not exceed 1% of design air flow at 1.5 times the unit's highest design operating static pressure.

AHU ACCESS

Access doors shall be provided to allow access to each section of the AHU from both sides.

Doors shall be constructed of same materials and same thickness as wall casings specified above in accordance with Fig. 6-12 of SMACNA *HVAC Duct Construction Standards - Metal and Flexible*. Doors in the cooling coil section and downstream of the cooling coil shall have a double gasket seal with an integral thermal break.

Arrange door to open against the section's operating pressure.

Doors shall include the following:

Latches: Provide high compression latches operable from both sides of the doors.

View Ports: Provide 9" x 9" view port in each door constructed of double-pane Mylar filled with inert gas.

Test Port: Each door shall have a 1" diameter test port.

Size: Minimum 24 inches wide by full height of unit casing up to a maximum height of 72 inches.

FAN SECTION

Fan Arrays:

Fan section shall house multiple plenum fan/motor “cubes”. Each fan/motor “cube” will be provided with an individual back-draft plate/damper.

Multiple fan and motor “cubes” shall be mounted and stacked in a parallel configuration to provide a uniform air flow and velocity profiled across the entire air way tunnel cross section. The fan section shall be on a common vibration base and equipped with vibration control.

Connect fan discharges to section divider wall with flexible connectors.

Each fan cube shall be wired to an individual disconnecting means for each fan motor. Wire sizing shall be determined, and installed, in accordance with NEC. Note: VFD (no bypass) will be provide for each fan,

Each fan assembly shall be supplied with a complete flow measuring system; The flow measuring station shall not obstruct the inlet of the fan and shall have no effect on fan performance (flow or static) or sound power levels. A surface mounted indicator, located on the unit exterior, shall provide a digital CFM readout, and an output control signal for use in the BAS as specified elsewhere.

COIL SECTION

Provide common or individual coil sections for heating and cooling coils as indicated on the Drawings. Air coils shall comply with Section 238216. Provide galvanized, aluminum alloy, or stainless steel sheet metal blank-offs to match unit casing inner panel around each coil to eliminate air bypass.

HUMIDIFIER SECTION

Where indicated on the Drawings, provide individual AHU section to house humidifier. **Inside wall panels and floor of this section shall be non-perforated stainless steel**. Humidifier shall comply with Section 238413 and be selected for the appropriate capacity within distance stated on drawings.

AIR FILTRATION SECTION

Provide air filtration section(s) as indicated on the Drawings to house particulate filters complying with Sections 234113 and 234123. Section shall include filter frames, either front loading or side loading as a function of AHU size.

UVGI SECTION

Provide UVGI section(s) as indicated on the Drawings complying with section 234213.

ACCESS SECTION

Provide minimum 24" deep access sections where indicated on the drawings or where required to provide access to AHU components.

ELECTRICAL CONNECTION

General: Electrical connection work for fans, etc. shall be in accordance with Section 230511.

Lighting and Lighting Control: Each section of AHU shall include factory wired, watertight light fixture(s) with LED lamps to provide illumination sufficient for required component maintenance. Provide exterior light switch adjacent to each access door. Lights and switches shall be factory wired so that each light switch will turn all unit lights on and off.

UNIT FACTORY TESTING

Standard Factory Tests: Fans shall be factory run tested to ensure structural integrity and proper RPM. All electrical circuits shall be tested to ensure correct operation before shipment of unit. Units shall pass quality control and be thoroughly cleaned prior to shipment. ***The manufacturer shall notify the A/E a minimum of two weeks prior to testing.***

Cabinet Leak Testing: The cabinet shall be tested at the unit's design operating static pressures for both the high and low pressure sides. Cabinet leakage shall not exceed a Leakage Class rating of 9 as defined by ANSI/ASHRAE Standard 111. Unit leakage rate shall not exceed ½ of 1% of unit cfm capacity at 1.25 times the operating static pressure (50 cfm minimum). Leak testing shall be performed by measuring the airflow used to pressurize the air handling unit positively or negatively at the cabinet design operating static pressure via a calibrated orifice method. All supply and return air openings shall be sealed along with the air seal at the supply fan bulkhead wall to isolate the high and low side of the unit. The unit shall then be pressurized until the appropriate operating pressures are achieved.

Cabinet Deflection Testing: A unit deflection test shall be conducted at 1.15 times the peak static pressure on the supply fan performance curve. Deflection shall not exceed L/200,

Performance Testing: Airflow measurements shall be performed in accordance with AMCA Standard 203, *Field Performance Measurements of Fan Systems*, utilizing a pitot tube traverse of the velocity pressures in a short section of straight ductwork. A test duct shall be attached to either the inlet or discharge opening(s) of the air handling unit. The duct shall be sized to increase the air velocity to approximately 2500 FPM. The test duct shall not induce non-uniform airflow that may result in additional system effects. Filter losses and external losses shall be simulated by reducing the cross sectional area of a component within the air handling unit. The test shall include two performance test points, which shall be achieved by throttling airflow as required.

Sound Testing: A sound pressure test of the assembled air handling unit shall be conducted with the unit operating at the desired rating point. The sound pressure measurements shall be taken at the unit inlet and outlet and three (3) feet from the unit casing.

Fan Vibration Testing: Fan wheel and shaft assemblies shall be dynamically analyzed after the fan, motor and drive assemblies have been installed in the unit. Fans shall be analyzed with an electronic balance analyzer with a tunable filter. Vibration measurements shall be taken on each bearing housing in the horizontal, vertical, and axial positions with the filter tuned to the fan RPM.

Report: A detailed report, including all data and test methods, shall be submitted to the A/E upon completion of testing, but prior to unit leaving the factory.

PART 3 - EXECUTION

INSTALLATION OF AIR HANDLING UNITS

Install air handling units where indicated, in accordance with equipment manufacturer's published installation instructions, and with recognized industry practices, to ensure that units comply with requirements and serve intended purposes. Arrange installation to provide access space around air-handling units for service and maintenance.

Where units are shipped in multiple sections, provide necessary hardware, tape sealer, and caulk required to field join and seal the sections. Provide sealing gasket for each assembly joint.

Indoor AHUs shall be installed level and plumb on housekeeping pads in accordance with Section 019913.

Coordinate piping installations and specialty arrangements with schematics on Drawings and with requirements specified in piping systems. Install piping adjacent to air-handling unit to allow for required access for service and maintenance.

Do not operate AHU until filters are in place. Install new filters in each AHU prior to final acceptance.

Touch-up factory paint as required to repair scratches or other damage.

FIELD QUALITY CONTROL

Upon completion of installation of air handling units, start-up and operate equipment to demonstrate capability and compliance with requirements. Field correct malfunctioning units, then retest to demonstrate compliance.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 237313

SECTION 238116 – DUCTLESS SPLIT SYSTEM AIR-CONDITIONING UNITS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

AHRI Compliance:

Testing and rating of packaged air-cooled heating and cooling units shall be in accordance with AHRI Standard 340/360 or AHRI Standard 210/240, as applicable.

Rate outdoor air-cooled unit sound power levels according to AHRI 270, *Sound Rating of Outdoor Unitary Equipment.*

ASHRAE Compliance: Refrigeration system shall be in accordance with ASHRAE 15, *Safety Code for Mechanical Refrigeration*.

North Carolina Building Code Compliance: Air-conditioning units shall meet or exceed the minimum efficiency rating required by the *North Carolina State Building Code: Energy Conservation Code* when tested, rated, and certified in accordance with AHRI 210/240 or 340/360, as applicable.

Extended Warranty: **The Contractor shall provide an extended parts and labor warranty on each refrigeration compressor in addition to guarantees and warranties required under the General Conditions to the Construction Contract.**

The *parts* portion of the warranty shall be directly from the manufacturer to the Owner.

The *labor* portion of the warranty shall also be provided directly from the manufacturer to the Owner.

Exception: Where a manufacturer labor warranty is not available, the Contractor shall provide a labor warranty directly to the Owner.

This warranty shall provide for repair or replacement of the covered compressor**, including removal and/or replacement of refrigerant,** that becomes inoperative as a result of defects in materials or workmanship within 4 years after the date ending the initial 1-year guarantee period for the Project.

Acoustic Criteria: HVAC equipment shall be selected and installed to comply with the acoustic criteria defined in Section 230510.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, dimensions, required clearances, weights, furnished specialties and accessories, and installation and start-up instructions.

PART 2 - PRODUCTS

SINGLE ZONE DUCTLESS SPLIT-SYSTEM

Description: System shall consist of a slim-silhouette wall-mounted indoor fan coil or 2-0”x2-0” 4-way blow cassette as shown on plans. Unit shall be coupled with an outdoor with inverter-driven scroll compressor designed for cooling-only or heat pump duty, as indicated on the Drawings. Refrigerant shall be R-32.

Indoor Unit: Provide indoor unit with wall-mounting bracket, consisting of the following:

Indoor 3-speed fan driven by a motor complying with the requirements of Section 230513.

Impact-resistance plastic casing with manual adjustable guide vane to adjust air discharge direction from side to side and integral, motorized air sweep louver to maintain uniform air distribution.

Removable, washable air filter, with minimum MERV of 6.

Refrigerant coil fins shall be constructed of continuous aluminum or copper configured plate-fin type. Provide minimum thickness of .0075”. Tubes shall be constructed of 5/8" seamless copper tubes in accordance with ASTM B 753. Provide minimum thickness of .025”. Suction and distributor piping shall be ASTM B 88, Type L copper tube with brazed joints. Casings shall be constructed of 16-ga continuous coated galvanized steel for coil heights 33" and smaller; 14-ga for coil heights over 33". Provide formed end supports and top and bottom channels. Provide 16-ga steel center tube support for coil lengths 42" to 96", 2 or more supports for coil lengths over 96". Factory test refrigerant coils at 450 psi and leak test at 300 psi under water; clean, dehydrate, and seal with dry nitrogen charge. Coils shall be coated with epoxy phenolic coating. Provide refrigerant distributor of venturi type with low pressure drop design, arranged for down feed and maximum of 12 circuits per distributor. Provide seamless copper tube suction header.

Drain pan with drain connection. On down flow units and all other coils that do not have a secondary drain pan or provisions to install a secondary or auxiliary pan, a water level monitoring device shall be installed inside the primary drain pan. The device shall shutoff the equipment served in the event that the primary drain pan becomes restricted. Devices installed in the drain line shall not be permitted.

Outdoor Unit: Provide outdoor unit consisting of the following:

Galvanized steel casing with an electrostatically applied, thermally fused acrylic or polyester powder coating.

Hermetic, inverter driven, variable speed scroll compressor.

Outdoor propeller fan driven by a DC motor with permanently lubricated bearings.

Refrigerant coil fins shall be constructed of continuous aluminum or copper configured plate-fin type. Provide minimum thickness of .0075”. Tubes shall be constructed of 5/8" seamless copper tubes in accordance with ASTM B 753. Provide minimum thickness of .025”. Suction and distributor piping shall be ASTM B 88, Type L copper tube with brazed joints. Casings shall be constructed of 16-ga continuous coated galvanized steel for coil heights 33" and smaller; 14-ga for coil heights over 33". Provide formed end supports and top and bottom channels. Provide 16-ga steel center tube support for coil lengths 42" to 96", 2 or more supports for coil lengths over 96". Factory test refrigerant coils at 450 psi and leak test at 300 psi under water; clean, dehydrate, and seal with dry nitrogen charge. Coils shall be coated with epoxy phenolic coating. Provide refrigerant distributor of venturi type with low pressure drop design, arranged for down feed and maximum of 12 circuits per distributor. Provide seamless copper tube suction header.

Low Ambient Control: Provide factory-installed low ambient damper assembly, fan speed control, or fan cycling control for cooling operation down to 0°F ambient. Include all other accessories necessary for low-ambient application.

Refrigerant Piping: Refrigerant piping shall be sized and furnished by the unit manufacturer and shall be insulated in accordance with Section 230719.

Electrical Connection: System shall be configured for a single electrical power service connection to the outdoor unit, with electrical service to be provided from the outdoor unit to the indoor unit utilizing factory-provided electrical connections. Make electrical connections in accordance with Section 230511.

Condensate Pump: Unit shall be equipped with integral condensate pump with a minimum of 29" lift.

Controls: A microprocessor-based controller shall be incorporated for system control, responding to inputs (setpoint, operating mode, schedule, etc.) from a wall-mounted, wireless device located where indicated on the Drawings. The controller shall sense the return air temperature, the indoor coil temperature and control both indoor and outdoor unit operation to maintain space temperature setpoint. For heat pump units, changeover from heating to cooling and the reverse shall be automatic.

PART 3 - EXECUTION

INSTALLATION

Install units where indicated, in accordance with equipment manufacturer's published installation instructions, and with recognized industry practices, to ensure that units comply with requirements and serve intended purposes.
Arrange installation to provide access space around units for service and maintenance.
Coordinate piping installations and specialty arrangements with schematics on the Drawings and with requirements specified above for refrigerant piping systems. Install piping adjacent to unit to allow for required access for service and maintenance.

Provide condensate drain piping and terminate drains outdoors or at floor drains as indicated on the Drawings.

Make electrical service connection in accordance with Section 230511.

Do not operate unit fans until filters are in place.

Touch-up factory exterior paint as required to repair scratches or other damage.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 238116

SECTION 238121 – PACKAGED AIR-COOLED HEATING AND COOLING UNITS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

Unit components shall meet the specific requirements of the following Specification sections:

Component	Section
Electrical service	230511
Support/Vibration Control	230529/230548/233300

QUALITY ASSURANCE

AHRI Compliance:

Testing and rating of packaged air-cooled heating and cooling units shall be in accordance with AHRI Standard 340/360 or AHRI Standard 210/240, as applicable.

Rate outdoor air-cooled unit sound power levels according to AHRI 270, *Sound Rating of Outdoor Unitary Equipment*, or AHRI 370, *Sound Rating of Large Outdoor Refrigerating And Air-Conditioning Equipment*, as applicable.

ASHRAE Compliance: Refrigeration system construction of packaged units shall be in accordance with ASHRAE 15, *Safety Code for Mechanical Refrigeration*.

North Carolina Building Code Compliance: Packaged units shall meet or exceed the minimum efficiency rating required by the *North Carolina State Building Code: Energy Conservation Code* when tested, rated, and certified in accordance with AHRI 210/240 or 340/360, as applicable.

Extended Warranty: **The Contractor shall provide an extended parts and labor warranty on each refrigeration compressor in addition to guarantees and warranties required under the General Conditions to the Construction Contract.**

The *parts* portion of the warranty shall be directly from the manufacturer to the Owner.

The *labor* portion of the warranty shall also be provided directly from the manufacturer to the Owner.

Exception: Where a manufacturer labor warranty is not available, the Contractor shall provide a labor warranty directly to the Owner.

This warranty shall provide for repair or replacement of the covered compressor**, including removal and/or replacement of refrigerant,** that becomes inoperative as a result of defects in materials or workmanship within 4 years after the date ending the initial 1-year guarantee period for the Project.

Acoustic Criteria: HVAC equipment shall be selected and installed to comply with the acoustic criteria defined in Section 230510.

Unit shall conform to UL 1995/CSA 22.2 #236 for construction of packaged air conditioner and shall have UL/CSA label affixed to rooftop package.

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, dimensions, required clearances, weights, furnished specialties and accessories, and installation and start-up instructions.

HANDLING

Comply with manufacturer's installation instructions for rigging, unloading, and transporting units. Protect units from physical damage. Leave factory shipping covers in place until installation.

PART 2 - PRODUCTS

GENERAL UNIT DESCRIPTION

Unit(s) furnished and installed shall be packaged units as specified on the contract documents and within these specifications. Cooling capacity ratings shall be based upon AHRI Standard 340/360. Unit(s) shall consist of insulated weathertight casing with compressors, air cooled condenser coil, condenser fans, evaporator coil, filters, gas heating coil, supply and relief fan motors and drives, and unit controls as specified. Units shall operate in heat pump duty.

Package units shall be constructed for installation on a plenum curb providing full perimeter support under air handler section and pedestal support under condenser section.

Unit(s) shall be factory run tested to include the operation of all fans, compressors, heat exchangers, and control sequences.

Unit(s) shall have labels, decals, and/or tags to aid in the service of the unit and indicate caution areas.

UNIT CASING

Cabinet: Exterior panels shall be zinc coated galvanized steel painted with a slate gray baked enamel finish durable enough to withstand a minimum of 672 hours consecutive salt spray application in accordance with standard ASTM B117. Screws shall be magnigard coated.

Refrigeration components and compressor shall be accessible through removable louvered panels as standard. Unit air handling section shall have a pitched roof and laminated double-wall construction with polyurethane foam core injected between sheet metal panels. Insulation value shall be R9. All interior surfaces shall be suitable for cleaning per ASHRAE 62. All access doors and panels shall have closed cell gaskets. All door, roof and base panels shall have a thermal break.

Unit base shall be watertight with heavy gauge formed load-bearing members.

Access Doors: Access doors shall be hinged with a single, exterior mounted, height and tension adjustable handle to provide positive latching at three points. Access doors shall provide a door stop mechanism to latch the door in the open position to prevent unsafe door closure by wind. Serviceable compartments in the air handler such as filters, evaporator coil, supply fan and variable frequency drives shall have doors of laminated, double-wall construction. This construction shall use a polyurethane foam core between the exterior sheet metal pane and the interior line, with an insulating value of R9. Three single wall doors shall be provided for access to the control panel.

ELECTRICAL POWER CONNECTIONS

General: The unit shall be provided with single-point power connection, factory-wired to the power connection lug set. Electrical connection work shall be in accordance with Section 230511.

Provide Phase Voltage Monitor. Shall protect 3-phase equipment from phase loss, phase reversal and phase imbalance. Any fault condition shall produce a Failure Indicator LED and send the unit into an auto stop condition. cULus approved.

Motors

Motors shall be rated for continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

Capacity and torque characteristics shall be sufficient for motor to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or service factor.

All motors shall meet the NEMA Premium™ Efficiency Standards.

All electric motor efficiencies shall comply with energy efficiency requirements of Code of Federal Regulations Title 10, Chapter II, Part 431, Subpar B “Electric Motors”.

Polyphase motors, unless indicated otherwise, shall be in accordance with NEMA MG 1, Design B, medium induction open dripproof (ODP) type, 1.15 service factor, Class F insulation, rated as "Premium" efficiency motors by NEMA.

Motors installed on State of North Carolina projects shall comply with the requirements of Senate Bills 668 and 1946, as applicable.

Motors located outdoors shall comply with the following:

Motor shall be TEFC, Cast Iron Construction Only (aluminum construction is prohibited) complying with the requirements of IEEE-45 *Recommended Practice for Electric Installations on Shipboard* and be classified as a “Marine Motor.” Motor construction shall include a shaft slinger on the opposite pulley end and frame surface under conduit box base shall be flat to ensure full gasket fit and prevent water entry. Nameplate shall clearly state "Marine Motor."

Motor shall be equipped with cartridge or strip heaters placed within the motor that are energized during non-operating periods to maintain the temperature inside the motor 5-10^{0}F warmer than the ambient air. Power heaters from line side of motor starter and Interlock heaters through a normally closed auxiliary contractor of the motor starter so that they are energized when the motor is not running and de-energized when the motor is running.

Motor bearings shall be regreasable, shielded, antifriction ball bearings suitable for radial and thrust loadings.

Motor frames shall be steel.

Motors shall be used with variable frequency drives and shall comply with the following additional requirement(s):

Motor windings shall be copper magnet wire with moisture-resistant insulation varnish and be designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulation inverters. Motors shall comply with NEMA MG 1, Part 31, to provide windings capable of withstanding up to 1600 peak volts with a rise time of 0.1 µs.

AIR FILTERS

Filters shall mount integral within unit casing and be accessible via hinged access panels.

Provide filter monitoring. A factory-installed, differential pressure transducer shall be piped to both sides of the final filter to indicate status. Transducer shall maintain +/- 5 percent accuracy within operating temperature limits of -20°F to 120°F. Transducer shall be mounted in a unit control box and report status through unit control display.

Provide 2” MERV 9 pleated pre-filters and 4” MERV 13 final filters. Filters shall slide into an extruded aluminum rack.

Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters with holding frames and with MERV rating of 9-16 and thickness as indicated on the Drawings.

Smoke And Flammability Limits: UL 900, Class 1.

Media: Interlaced glass or synthetic fibers coated with nonflammable adhesive.

Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

Media shall be coated with an antimicrobial agent.

Separators shall be bonded to the media to maintain pleat configuration.

Welded wire grid shall be on downstream side to maintain pleat.

Media shall be bonded to frame to prevent air bypass.

Support members on upstream and downstream sides to maintain pleat spacing.

Filter-Media Frame: Cardboard frame with perforated metal retainer sealed or bonded to the media.
Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.

Capacities and Characteristics: Rated airflow, size, and pressure losses shall be as indicated on the Drawings.

FANS – SUPPLY

Supply fan shall be single width, single inlet plenum fans. Fan blades shall be backward inclined. Plenum fans shall be direct-driven. Entire assembly shall be completely isolated from unit and fan board by 2" deflection spring isolation.

Beltless fan shall not require routine maintenance such as fan bearing lubrication, belt tensioning and replacement, sheave alignment, and setscrew torque checks.

Supply fan motors shall be open drip-proof. All supply fans shall be dynamically balanced in factory. Each motor shall have its own Variable Frequency Drive.

Supply fan shall be test run in unit and shall reach rated rpm. All 60 Hz supply fan motors shall meet the Energy Independence Security Act of 2007 (EISA).

Provide variable frequency drive (VFD) bypass. Supply fan bypass control shall provide airflow at 60 Hz in the event of drive failures.

DAMPERS

Control Dampers: Provide opposed blades for modulating control. Dampers shall be constructed of 0.108-inch-minimum thick steel or 0.125-inch-minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch-thick steel with maximum blade width of 8 inches and maximum length of 48 inches. All other dampers shall be constructed of G90 galvanized steel with zinc-plated shafts and hardware exposed to the airstream.

Secure blades to 1/2-inch-diameter axles with oil-impregnated sintered bronze blade bearings, blade-linkage hardware, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of each blade.

Operating Temperature Range: From minus 40 to plus 250° F.

Edge Seals: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for Leakage Class I according to ANSI/AMCA 500-D.

HEATING SECTION

General: Provide slip-in electric coils with disc type automatic reset thermal cutouts for primary over-temperature protection and with disc type load-carrying manual reset thermal cutouts, factory-wired in series with each heater stage, for secondary protection. Heat limiters or other fusible overtemperature devices are not acceptable. Provide electric coils with the following additional construction features:

Open-Coil Electric Element: Construct coils with resistance wire type A of 80 percent nickel/20 percent chromium, insulated by floated ceramic bushings. Recess bushings into casing openings and secure on supporting brackets, spaced 4" o.c. maximum. The heating wire for each stage shall be strung across the entire face of the coil to prevent stratification when operating at less than full capacity.

Heaters shall be rated for the voltage, phase, and number of heating stages as indicated in the schedule. All three phase heaters shall have equal, balanced, three phase stages. All internal wiring shall be stranded copper with 105 degrees C insulation and shall be terminated in crimped connectors or box lugs.

Terminal blocks shall be provided for all field wiring and shall be sized for installation of 75 degrees C copper wire in accordance with NEC requirements.

Trim: All terminals and nuts shall be constructed of stainless steel, and terminal insulators, brackets and bushings shall be constructed of ceramic and securely positioned.

Casings: Heater frames and terminal boxes shall be constructed of aluminized or galvanized steel. Terminal box shall be NEMA 1 construction and shall be provided with a hinged, latching cover and multiple concentric knockouts for field wiring.

Heater controls shall be factory wired in insulated enclosure and shall be provided complete with the items indicated below:

Automatic reset thermal cutouts prewired into control circuit

Differential pressure switch

Limit control duty magnetic contactors

Control circuit transformer for 24V control

Non-fused safety disconnect switch interlocked with heater terminal box cover

SCR Modulating Control

EVAPORATOR COIL SECTION

Provide heavy duty aluminum fins mechanically bonded to copper tubes. Evaporator coil shall be inter- circuited to maintain active coil face area at part load conditions. Coil shall also utilize internally enhanced tubing for maximum efficiency.

Provide electronic expansion valve. Shall be electronically controlled by the factory controller. This fully integrates expansion valve control with unit operation to ensure optimal equipment reliability and efficiency. Expansion valves shall be 2500 step valves for precise refrigerant control and shall be driven closed during off cycles to minimize refrigerant migration and protect compressors. Valve position shall be displayed at the user interface to assist field diagnostics.

Provide double sloped stainless-steel drain pan to assure positive drainage of condensate from the unit casing.

AIR-COOLED CONDENSER SECTION

Condenser coils shall have all Aluminum Microchannel coils. All coils shall be leak tested at the factory to ensure pressure integrity. The condenser coil is pressure tested to 650 psig. Subcooling circuit(s) shall be provided as standard.

Provide subcooling circuit(s) integral with condenser coils to maximize efficiency and prevent premature flashing of liquid refrigerant, to a gaseous state, ahead of the expansion valve.

Provide vertical discharge, direct drive, condenser fans with aluminum blades and zinc plated steel hubs. Condenser fan motors shall be three-phase motors with permanently lubricated ball bearings, built-in current and thermal overload protection and weather-tight slingers over motor bearings.

Provide factory-installed louvered steel coil guards around perimeter of condensing section to protect the condenser coils, refrigerant piping and control components from damage resulting from hail, flying debris, and vandalism. Louvered panels shall be fabricated from heavy gauge, pre-painted galvanized steel with a baked, polyurethane enamel finish, and be rigid enough to provide permanent protection for shipping and pre-/post- installation. Course wire mesh is not an acceptable material for coil guards.

Reversing Valves: 4-way low voltage solenoid valve piping to direct hot gas flow to the indoor coil when energized (heating mode) and to the outdoor coil when de-energized (cooling mode).

Heating: Provide multistage heating control. For each refrigerant circuit, the first stage shall energize the reversing valve, directing hot gas to the indoor coil. On a continued fall in space temperature, energize the supplemental heat.

Defrost Cycle: When in the heating cycle, a buildup of ice on the outdoor coil shall result in the controls de-energizing the reversing valve, directing hot gas from the compressor to the outdoor coil to defrost it. The outdoor fan(s) shall stop. Once the ice melts, energize the reversing valve shall be energized to the heating position to direct hot refrigerant gas to the indoor coil. The outdoor fan shall operate.

REFRIGERATION SYSTEM

Compressor shall be industrial grade, energy efficient direct drive 3600 RPM speed scroll type. The motor shall of a suction gas cooled hermetic design. Compressor shall have a centrifugal oil pump with dirt separator, oil sight glass, and oil charging valve. Crankcase heaters will be standard on each compressor to minimize amounts of liquid in the oil sump when unit is off.

Provide with thermostatic motor winding temperature control to protect against excessive motor temperatures resulting from over-/under-voltage or loss of charge. Provide high and low pressure cutouts, and reset relay. Provide factory-installed compressor lockout thermostat to prevent compressor operation at low ambient conditions. Provide coil frost protection compressor unloading based on refrigerant circuit suction temperature to prevent coil frosting with minimum energy usage.

Provide Compressor Isolation. Factory installed valves both upstream and downstream of each compressor set shall enables isolation of compressors from the rest of the refrigeration system if service is required.

Compressors shall be variable capacity and capable of turning down to a minimum of 10%.

Units shall operate as heat pumps.

RELIEF SECTION

Unit shall be equipped with powered exhaust.

OUTDOOR AIR SECTION

Provide 0-100 Percent Modulating Economizer. Shall be operated through the primary temperature controls to automatically utilize OA for "free" cooling. Automatically modulated return and outside air dampers shall maintain proper temperature in the space. Economizer shall be equipped with an automatic lock out when the outdoor high ambient temperature is too high for proper cooling. When not in economizer economizer damper shall stay at a minimum position when occupied as determined by TAB.

HOT GAS REHEAT

Humidity Control:

Provide hot-gas bypass refrigerant control for capacity control with continuous dehumidification, as required.

Provide first-stage condenser consisting of hot-gas reheat coil downstream of cooling coil.

CONTROLS

The controller shall be an application-specific, programmable controller that is factory installed and designed to control packaged HVAC equipment. A 7” user interface features a touch-sensitive color screen that provides facility managers with at-a-glance operating status, performance monitoring, scheduling changes and operating adjustments. Provide automated controller backup on SD card and optional features such as secure remote connectivity, wireless building communications, mobile device connectivity and custom programming and expandable I/O.

Provide immediate start up upon power failure. Rapid Restart shall begin immediately after recovery from a power loss and work by restarting the compressors and supply fan quickly to provide full cooling within two to three minutes.

Provide all necessary controls to operate a single zone system to maintain return air temperature or space temperature as selected. The controller shall coordinate the economizer control and the stages of cooling and heating to maintain temperature. Include factory installed and tested VFDs to provide supply fan motor speed modulation. Factory controller shall provide at minimum the points shown on drawings to the DDC.

Provide BACnet Communication Protocol. The controller shall support standard BACnet® communication protocol BACnet®/IP.

Unit controllers shall interface seamlessly with the BACnet direct digital control (DDC) system specified in Sections 230913 and 230923, fully complying with the operational requirements for “Control Units” specified in Section 230923.

Coordination: The Contractor shall be responsible for coordination between the controls system sub-contractor and the unit controller manufacturer/vendor to ensure that required control interface is implemented, resulting in full interoperability between unit controls and the DDC system.

Unit shall be provided with fused disconnect per specification section 230511.

PART 3 - EXECUTION

INSTALLATION

Install units where indicated, in accordance with equipment manufacturer's published installation instructions, and with recognized industry practices, to ensure that units comply with requirements and serve intended purposes. Arrange installation to provide access space around units for service and maintenance.

Do not operate unit fans until filters are in place. Install new filters in units prior to final acceptance.

Touch-up factory exterior paint as required to repair scratches or other damage.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 238121

SECTION 238216 – AIR COILS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction, and NEC as applicable to construction and installation of electric coils.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's specifications for terminal units showing dimensions, capacities, ratings, performance characteristics, gages and finishes of materials, and installation instructions.

PART 2 - PRODUCTS

WATER COILS

Heating Coils:

Fins: Construct of continuous aluminum or copper configured plate-fin type, as indicated on the Drawings. Provide minimum thickness of .0075”.

Tubes: Construct of seamless copper tubing in accordance with ASTM B 743, expanded into fin collars for permanent fin-tube bond and expanded into header for permanent leaktight joint. Provide minimum thickness of .025”.

Headers: Construct of cast iron for coils 33" high and smaller. Construct of round seamless copper tube for coils over 33" high.

Casings: Construct of 16-ga continuous coated galvanized steel with fins recessed into channels to minimize air bypass.
Testing: Factory test coils at 300 psi, leak test at 200 psi under water.

Coil Types: Provide the following coil types as indicated, and as scheduled on the Drawings:

Hot Water Coils: Provide 1- or 2-rows, 5/8" tubes, single tube continuous circuit, same-end connection coil.

Cooling Coils:

Fins: Construct of continuous aluminum or copper configured plate-fin type, as indicated on the Drawings. Provide minimum thickness of .0075”.

Tubes: Construct of 5/8" seamless copper tubes in accordance with ASTM B 753. Provide minimum thickness of .025".

Casings: Construct of 16-ga continuous coated stainless steel for coil heights 33" and smaller; 14-ga for coil heights over 33". Provide formed end supports and top and bottom channels. Provide 16-ga steel center tube support for coil lengths 42" to 96", 2 or more supports for coil lengths over 96".

U-Bends: Construct of 5/8" copper tubes, machine die-formed on each end to provide accurate fit for silver brazed joints.

Testing: Proof test water coils at 300 psi and leak test at 200 psi under water.

Headers: Provide cast-iron inlet and outlet headers for coil heights 33" and smaller. Provide seamless copper tube headers for coil heights over 33".

PART 3 - EXECUTION

INSTALLATION OF WATER COILS

Install coils as indicated, and in accordance with manufacturer's installation instructions.

Mount coils on steel supports to form banks or stacks as indicated, brace, secure to air intake chamber. Place in location to permit installation of bypass damper if required, provide steel baffles where required to prevent bypassing of air.

Pitch coil casings for drainage, not less than 1/8" toward return connections, except where drainage feature is included in coil design.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 238216

SECTION 238219 - FAN COIL UNITS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

ARI Compliance: Test and rate fan-coil units in accordance with ARI Standard 440 "Room Fan-Coil Air Conditioners."

UL Compliance: Construct and install fan-coil units in compliance with UL 883 "Safety Standards for Fan Coil Units and Room Fan Heater Units."

Acoustic Criteria: HVAC equipment shall be selected and installed to comply with the acoustic criteria defined in Section 230510.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's specifications for terminal units showing dimensions, capacities, ratings, performance characteristics, gages and finishes of materials, and installation instructions.

Samples: Submit samples of manufacturer's standard cabinet paint colors when exposed.

PART 2 - PRODUCTS

FAN COIL UNITS

General: Provide fan coil units, with or without cabinets as indicated on the Drawings, of capacities, style, and having accessories as scheduled on the Drawings. Include chassis, coils, removable fan and motor board, drain pan assembly, filter, insulation, hydronic piping and control valve package, and accessories as indicated on the Drawings. Provide cabinet for units exposed to view.

Chassis: Construct chassis of galvanized steel with flanged edges. For floor-mounted units, provide leveling screws.

Unit Liner: Enclosures shall be internally insulated with minimum ¾” thickness of elastomeric closed cell foam insulation. Insulation shall conform to UL 181 for erosion and NFPA 90A for fire, smoke and melting, and comply with a 25/50 Flame Spread and Smoke Developed Index per ASTM E-84 or UL 723. Additionally, insulation shall comply with Antimicrobial Performance Rating of 0, no observed growth, per ASTM G-21. All leading and trailing edges shall be protected from airstream contact by metal flanges, channels, etc.

Cabinet: For units exposed to view, provide cabinet constructed of 14-ga steel for floor mounted units and 18-ga for suspended ceiling units. Cabinet shall consist of removable panels with baked enamel finish in manufacturer's standard color selected by the A/E. Cabinet configuration shall be as indicated on the Drawings.

Coils: Provide individual heating and cooling coils in compliance with the requirements of Section 238216. **Coils with individual heating and cooling tubing that share common fins are prohibited.**
Unless specifically indicated otherwise, the heating coil shall be downstream of the cooling coil, i.e., in the reheat position.

Drain Pan: Construct of Type 304 stainless steel. Insulate with 1/2" thick non-hydroscopic insulation. Provide 3/4" drain connection. Drain pan shall extend under hydronic piping and control valve assembly.

On down flow units and all other coils that do not have a secondary drain pan or provisions to install a secondary or auxiliary pan, a water level monitoring device shall be installed inside the primary drain pan. The device shall shutoff the equipment served in the event that the primary drain pan becomes restricted. Devices installed in the drain line shall not be permitted.

Fan and Motor Board: Provide removable fan and motor board as follows:

Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.

Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements of Section 230513.

Wiring Termination: Connect motor to chassis wiring with plug connection.

Filters: Provide 1" flat panel filters in accordance with Section 234113 with minimum MERV of 8.

Hydronic Piping Package: Provide copper tubing package, with control valve, as indicated on the Drawings in accordance with Sections 230521, 230523, and 232113, insulated in accordance with Section 230719.

Accessories: Provide the following accessories as indicated and/or scheduled.

Cabinet Discharge and Return Grille Panels: Provide 14-ga galvanized steel, stamped integral grilles, with access doors.

Sub-Bases: Provide 14-ga steel sub-base for floor mounted, vertical units, height as indicated on the Drawings.

Extended Oilers: Provide plastic motor oiler tubes extending to beneath top discharge grille.

PART 3 – EXECUTION

INSTALLATION OF FAN COIL UNITS

Install fan coil units as indicated, and in accordance with manufacturer's installation instructions.

Suspended units shall be hung from building structure using threaded steel rods in accordance with Section 230529.

Protect units with protective covers during balance of construction.

Do not operate units until filters are in place. Provide new filters prior to final acceptance.

Touch-up factory exterior paint as required to repair scratches or other damage.

FIELD QUALITY CONTROL

Upon completion of installation of fancoil units, start-up and operate equipment to demonstrate capability and compliance with requirements. Field correct malfunctioning units, then retest to demonstrate compliance.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 238219

SECTION 238233 – Convectors

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Test and rate baseboard and finned tube radiation in accordance with I=B=R, provide published ratings bearing emblem of I=B=R.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's specifications for terminal units showing dimensions, capacities, ratings, performance characteristics, gages and finishes of materials, and installation instructions.

PART 2 - PRODUCTS

TYPE

DRAFT BARRIER HEATERS

General: Provide industrial grade, electric, wall mounted convectors having cabinet sizes and in locations as indicated, and of capacities, style, and having accessories as scheduled.

Cabinets: Minimum 12-ga aluminum case with zinc chromate primer and neutral gray baked-on finish. Air intake grilles shall be on front of unit with top discharge.

Elements: Nickel-Chromium resistance wire encased in sheath. Aluminum fins shall be mechanically bonded to stainless steel tube.

Thermostat: Built-in with over-temperature cutout and automatic reset.

Disconnect: Unit shall be furnished with integral factory wired disconnect switch located behind removable grill or panel. Disconnect shall be oriented such that such that no contact with “live” wiring is required to access disconnecting means.

PART 3 - EXECUTION

INSTALLATION OF CONVECTORS

Install convectors as indicated, and in accordance with manufacturer's installation instructions.

Locate convectors as indicated.

ADJUSTING AND CLEANING

After construction is completed, including painting, clean unit exposed surfaces, vacuum clean terminal coils and inside of cabinets.

Retouch any marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 238233

SECTION 238413 - HUMIDIFIERS

1. GENERAL

a. DESCRIPTION

i. High pressure atomising adiabatic humidifier, works on drinking and demineralised water. Pressure is provided by a piston pump (max. pressure 80 bars) without the aid of compressed air.

b. WORK REQUIRED

i. Installation according to the manufacturer's specifications, performed by technical personnel
ii. System commissioning performed by manufacturer

c. DOCUMENTATION

i. Technical manual for installation, instructions on safety, configuration and operation, complete with dimensions, technical specifications, performance, water circuit and wiring diagrams, standards and specifications for safe installation, guide for commissioning and operation, diagnostics, list and identification of spare parts, 2D/3D drawings.

d. QUALITY

i. CE (EMC: EN 61000-6-2, EN 61000-6-4; LVD: EN 60204-1; RoHS: EN IEC 63000)
ii. ETL (in accordance with UL 998 and UL 508A)
iii. EAC
iv. VDI 6022 part 1: 2018-01 v. VDI 3803 part 1: 2020-05
vi. SWKI VA 105-1: 2015-08
vii. ÖNORM H 6021: 2016-08
viii. WaterMark WMTS 101
ix. ISO 9001:2015 - ISO 14001:2015 - ISO 45001:2018 (manufacturer)

2. PRODUCT

a. [definition of the apparatus, technology]

i. High pressure atomising adiabatic humidifier, consisting of:
- a *main* cabinet containing the controller and the volumetric pump
- a *secondary* cabinet containing the controller for each zone
- a high pressure *rack* atomisation system, customised for each application.

b. [general features and construction]

i. Volumetric piston pump.
ii. Pressure gauge upstream of the pump.
iii. Feedwater and outlet water pressure gauges
iv. Built-in conductivity meter
v. Pressure sensor (0.5 bars) to avoid air lock inside the pump
vi. Safety valve (5.5 bars) on pump bypass
vii. Safety valve (80 bars) on outlet
viii. Bypass water temperature probe, drain solenoid valve and thermostatic valve (63°C, redundant safety) to avoid pump overheating
ix. Maximum pressure switch (90 bars, redundant safety on outlet safety valve) for unit shutdown and safety drain
x. Pulsation damper

c. [capacities and variants]

i. control type:
- Single zone:
  - a variable flow-rate control
  - b constant pressure control
- Model with silicone-free AISI 316 stainless steel volumetric pump.

d. [feedwater and drain water]

i. The humidifier shall only use demineralized drinking water (0.054 - 50 µS/cm).

ii. Water treatment skid to be included with the humidifier as part of a self contained package.

a. The purified water system shall be provided as a package by the system manufacturer with all components, interconnecting piping and controls necessary to provide the quality and quantity of purified water as shown on the drawings.

b. Provide purified water systems consisting of one or more of the following elements and distribution piping as indicated on the drawings:

Sediment filter(s)
Water softener
Carbon filter
Reverse osmosis (RO) filtration
Mixed bed deionization tanks
Purified water storage tank and distribution/recirculation pumps
UV oxidation sterilizer(s)
Final filters
Controls

.

e. [power supply specifications]

i. Cabinet-pumping station power supply:
- 208 VAC 1-phase 50/60 Hz on sizes 150 - 500 kg/h UL certified

Secondary cabinet power supply:
- 208 VAC 1-phase 50/60 Hz UL certified

ii. RO system
- RO System: 220 VAC 1-phase 50/60 Hz

Ro Pre-treatment System (Part of Skid):
- 220 VAC 1-phase 50/60 Hz

f. [control, characteristics]

i. 2 analogue inputs for humidity/temperature probes or external request signal. The type of electrical signal for both can be selected on the keypad between: on/off (humidistat), NTC, 0- 10 V, 2-10 V, 0- 1 V, 0- 20 mA and 4- 20 mA
ii. Analogue input for auxiliary temperature probe
iii. ON/OFF digital input to enable the remote pumping station
iv. ON/OFF digital input to enable the remote high pressure atomising rack connected to the pumping station.
v. ON/OFF digital input to enable signal from external air flow/pressure switch.
vi. ON/OFF digital input reserved for any alarm signals from an external reverse-osmosis water treatment system.
vii. ON/OFF digital input reserved for a water leakage detector or flooding sensor.
viii. ON/OFF digital output to signal high pressure atomising rack status, active/inactive.
ix. ON/OFF digital output to signal low temperature inside the cabinet and possibly start/stop an external frost protection device.
x. Cumulative alarm relay to signal faults and/or malfunctions to a supervisory system.
xi. Digital output contact with configurable logic with 7 options:
- pump status (pump on/off)
- unit status (unit powered/not powered)
- maintenance warning (warning on/off)
- missing water warning (warning on/off)
- inlet water low pressure alarm (alarm on/off)

- freezing water alarm (alarm on/off)
- rack preheating probe low temperature warning (warning on/off)

xii. 17 production and modulation algorithms available to the user:

- on/off
- on/off - modulating based on humidity limit probe rH%
- on/off - modulating based on temperature limit probe T
- Production proportional to external analogue signal
- Production proportional to external analogue signal + temperature limit probe
- Production proportional to external analogue signal + humidity limit probe
- Production proportional to temperature probe reading
- Production proportional to 2 temperature probes reading for direct in-room application (weighted average of the 2 probes)
- Production proportional to 2 temperature probes reading + humidity limit probe for direct in-room application (weighted average of the 2 probes)
- Production proportional to 3 temperature probes reading for direct in-room application (weighted average of the 3 probes)
- Production proportional to 2 humidity probes reading for direct in-room application (weighted average of the 2 probes)
- Production proportional to 3 humidity probes reading for direct in-room application (weighted average of the 3 probes)
- Production proportional to humidity probe reading
- Production proportional to temperature probe reading + temperature/humidity limit probe
- Production proportional to humidity probe reading + temperature/humidity limit probe
- Production proportional to dew point temperature
- Production proportional to dew point temperature +humidity limit probe xiv. The humidifier shall be able to control atomised water production by reading the air temperature downstream of the AHU preheater

xiii. Intuitive graphical 7'' touch display through which the whole humidification system can be configured and controlled

xiv. The touch display can be used to view and modify the system parameters, as well as reset any warnings or alarms.

xv. Flow-rate control mode: continuous modulation from 5% to 100% of the distribution system water flow-rate (the outlet pressure varies from 25 to 70 bars depending on the water flow-rate).

xvi. Pressure control mode: the outlet pressure is kept at the set point (70 bars), varying the pump speed when the load in the downstream water circuit changes; the pressure can be set by the user.

xvii. Pressure control mode: up to 64 flow-rate control values.

xviii. The pumping station can control up to 22 (external fill or drain valves.

xix. The pipes that make up the atomising rack are automatically emptied by opening the drain valves every time the system stops atomising, as required by the strictest applicable regulations, while also preventing the nozzles from dripping

xx. The pipes that make up the atomising rack are automatically washed when the humidifier is switched on

xxi. The pipes that make up the atomising rack are automatically emptied and washed periodically during periods of inactivity (the washing cycle can be set in relation to the needs of the application directly by the user); this guarantees compliance with the highest hygiene standards

xxii. Atomisation is preceded by a complete filling cycle on all of the lines making up the system, until reaching the correct atomisation pressure. This ensures that there are no leaks from the nozzles during transient phases

xxiii. Display of feedwater conductivity

xxiv. Display of water bypass temperature

xxv. Selection of unit of measure (SI or IP)

xxvi. Automatic maintenance warning

xxvii. The humidifier supplies water at constant pressure, even without any directly-controlled external valve

xxviii. Weekly scheduler

xxix. Manual procedure for testing individual devices

xxx. Procedure for cooling the pipes inside the cabinet during extended periods of inactivity, which can be activated in the event of exposure of the cabinet or the equipment room to sunlight.

xxxi. Configuration wizard executable during commissioning from the touch display for correctly setting up the entire system (all supplied zones). Configuration shall be possible by uploading a file from USB port.

xxxii. Remote connectivity shall be available through dedicated cloud portal. The humidifier shall be able to be controlled and accessed remotely through an independent standalone connection to said cloud portal, especially for troubleshooting purposes. Checking and editing variables and an overview of the unit shall be made available through this system. Local connectivity shall be available through dedicated local supervisor. Checking and editing variables and an overview of the unit shall be made available through this system.

g. [performance data]

i. relative humidity control accuracy shall be up to +/- 1 - 2% around relative humidity setpoint.

h. [safety, protection and hygiene devices]

i. No biocides need to be added to the water.

i. [communication interfaces, display, connectivity]

i. Ethernet port to communicate with BACNet protocols, without requiring an additional external device.

j. [distribution systems]

i. High pressure atomisation system for AHUs/ducts:

- High pressure atomising rack with pre-wired solenoid valves and labelled electrical cables
- High pressure atomising rack with AISI 304 nozzles and customised according to the inside dimensions of the duct.
- The atomisation system shall be automatically emptied when atomisation ends.
- Suitable for operation up to 100 bars, suitable for demineralised water with conductivity 0.054 - 50 µS/cm and microbiologically inert.
- Water racks and solenoid valve coils in compliance with DIN EN 846 and DVGW W 270
- Normally Closed fill valves, 24 VAC
- Normally Opened drain valves, 24 VAC
- Atomising nozzles available with flow-rates 1.45; 2.8; 4.0 l/h at 70 bars, made from AISI 316, anti-drip ball valve and rotating internal body
- 70 bars, made from AISI 316, anti-drip ball valve and rotating internal body
- Stainless-Steel Tubing, Fittings, and Valves:

1 Stainless-Steel Tube: ASTM A 270, Grade TP304L or TP316L, seamless, sanitary tube of pharmaceutical quality, Schedule 40 unless otherwise indicated.

Stainless-Steel Tube Fittings: Fabricated of same material and thickness as tubing for socket welding.

Finish on Inside Surface of Tubes and Fittings: Ra 20 micro-inch maximum roughness.

Stainless-Steel Ball Valves:

Standard: MSS SP-110.
Minimum CWP Rating: 1000 psig (6895 kPa).
Body Material: Electropolished stainless steel.
Body Design: Three-piece bolted body type.
End Connections: Socket welding.
Seats: PTFE.
Stem: Electropolished stainless steel.
Ball: Electropolished stainless steel, vented.
Port: Full.
Handle: Lever type.

Transition Fittings: Couplings, flanges, or other manufactured fittings shall be same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

k. [accessories]

i. Humidity probe rH% or temperature probe T for civil environments (rH% 10% - 90%; T -10°C - 60°C)

ii. Humidity probe rH% or temperature probe T for industrial environments, min. protection rating IP54 (rH% 10% - 90%; T -20°C - 70°C)

iii. Humidity probe rH% for ducts, min. protection rating IP40 (rH% 10% - 90%)

iv. Humidity limit probe rH% for ducts, min. protection rating IP40 (rH% 0% - 100%)

v. Rack distribution system temperature probe: manage a probe positioned upstream of the rack so that atomisation is enabled when the temperature is optimal for correct absorption.

vi. The humidifier shall be able to communicate via the following protocols by default:

- BACnet Serial/IP
- *Secondary* zone cabinet for stand-alone control of up to 12 zones:
- The zone cabinet shall guarantee the same control logic as the *main* cabinet.

m. Basis of Design: Carel Acceptable Alternatives MeeFog and GoFog

3. EXECUTION

a. Installation in compliance with the manufacturer's specifications

b. Installation in compliance with applicable local laws and regulations

c. Water quality as per manufacturer's specifications.

END OF SECTION 238413

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SECTION 260000 - SUMMARY OF ELECTRICAL WORK

Engineer of Record for electrical work is Matthew J. Johnson, PE, Salas O'Brien Raleigh, Inc., 702 Oberlin Road, Suite 300, Raleigh, NC 27605 (919) 832-8118. Electrical work shall be defined by drawings numbered with the prefix "E", the general provisions of the Contract including General Conditions and Supplementary Conditions, Division 1 Specifications sections, and Division 26-28 Technical Specifications listed below. In addition, electrical work may be defined by reference to other documents from any of the above-named sources as well as by project addenda.



06/30/2025

DIVISION 26 - ELECTRICAL

Section	Title
260000	Summary of Electrical Work
260500	Basic Electrical Requirements
260519	Secondary Voltage Wires and Cables
260526	Grounding
260529	Supporting Devices
260533	Electrical Identification
260534	Raceways
260535	Electrical Boxes and Fittings
260593	Electrical Connections for Equipment
260596	Lighting Systems Commissioning
260800	Testing and Placing in Service
260923	Lighting Control Devices
260924	Lighting Relay Panel
262200	Low Voltage Transformers
262416	Panelboards
262726	Wiring Devices
262816	Enclosed Switches and Circuit Breakers
	Functional Performance Test Form – Occupancy Sensor
	Functional Performance Test Form – Photocontrol Switch
	Functional Performance Test Form – Relay Panel

DIVISION 27 - COMMUNICATIONS

Section	Title
270528	Telephone/Data Raceway System

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

Section	Title
283110	Fire Alarm System Modifications

END OF SECTION 260000

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SECTION 260500 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

SCOPE

The electrical design for this project is based on the requirements of the *National Electrical Code* (NEC), NFPA-70, 2020 Edition. Where not restricted to more stringent requirements by the Drawings and Specifications, the minimum requirements of the NEC shall prevail.

Contractor shall coordinate the work and equipment of this Division with the work and equipment specified elsewhere in order to assure a complete and satisfactory installation.

It is the intention of these Specifications and Drawings to call for finished work, tested and ready for operation. Whenever the words "supply," "provide," or "furnish" are used, it shall mean "furnish and install complete and ready for use at no additional cost."

Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the Work the same as if herein specified or shown.

Some items of equipment are specified in the singular; however, the Contractor shall provide and install the number of items of equipment as indicated on the Drawings, and as required for complete systems. The words “and” and “or” shall be interpreted in both the singular and plural sense (and/or) as appropriate to the use.

Electrical service entrance equipment arrangements for temporary and permanent connections to the Owner's system shall conform to the Owner's requirements. Coordinate circuit breakers with the existing system.

All ampacities or other conductor references where indicated or otherwise specified in the Drawings or Specifications are based on copper conductors. **Aluminum conductors are not acceptable and will not be permitted.**

DEFINITIONS

Definitions for "Concealed" and "Exposed" are provided for the purpose of specifying wiring methods or for defining the appearance of finished work and are not the same as definitions used in the National Electrical Code.

Concealed: Work within or behind various construction elements or in crawl spaces or trenches that is not exposed to view when the project is complete.

Exposed: Not "concealed" as defined above, or anything exposed to view when the project is complete.

Labeled: Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization accredited by NCBCC (North Carolina Building Code Council) to label electrical equipment and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

Listed: Equipment or materials included in a list published by an organization accredited by NCBCC (North Carolina Building Code Council) to label electrical equipment and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials, and whose listing states either that the equipment or material meets appropriate designated standards or has been tested and found suitable for use in a specified manner.

Wiring: Cable, raceways, fittings, mechanical supports, wire, junction boxes, device boxes, outlet boxes, switches, cutouts, and related items.

PART 2 – PRODUCTS (NOT USED)

PART 3 - EXECUTION

ENERGIZED SYSTEM WARNING

Extreme caution is enjoined with regard to work with and around energized electrical equipment. The Contractor is urged to coordinate all such activities with the Owner or the local electric utility so that electrical equipment may be de-energized as required to safely perform necessary construction activities as defined in the Drawings and Specifications. Suitable OSHA approved lockout-tagout procedures shall be used when circuits or equipment have been de-energized for the purpose of performing construction activities. All work practices related to worker safety are the complete responsibility of the Contractor.

DUTIES OF CONTRACTOR

The Drawings are generally diagrammatic in nature and are neither intended to show each fitting, box, elbow, offset, hanger, *etc.*, nor a complete detail of all work to be done. The Drawings are for the purpose of illustrating the type of system, showing raceway sizes, *etc.*, and special conditions considered necessary for the experienced mechanic to take off materials and lay out work. This Contractor shall be responsible for taking such measurement as may be necessary at the job and adapting his work to local conditions.

Contractor shall furnish and install all materials called for or reasonably implied in these Specifications and accompanying Drawings. Apparatus must be furnished complete and ready for operation in every respect. Materials and equipment called for in the Specifications and not indicated on the Drawings, or indicated on the Drawings and not called for in the Specifications, shall be furnished by the Contractor.

Contractor is responsible for familiarizing himself with the project area and details of the construction of building. Work performed under these Specifications that is installed improperly or which requires modification due to improper reading or interpretation of building plans shall be corrected or otherwise modified as directed by the A-E without additional cost to the Owner.

Contractor shall follow Drawings in laying out work and shall refer to drawings of other trades to verify exact spaces in which work will be installed. Arrange installed items in such a manner as to maintain maximum headroom and space conditions at all points. Where headroom or space conditions appear inadequate, A-E shall be notified before proceeding with installation.

INSPECTIONS

The contractor shall schedule inspections with the State Electrical Inspector through the State Construction Office (SCO), Consulting Services section. This shall include all inspections of concealed work, interior and exterior, as well as intermediate and final reviews. All scheduling of electrical inspections with the SCO electrical inspector shall be Monday thru Friday unless specifically exempted and approved by SCO.

COOPERATION WITH OTHER TRADES

The Contractor shall give full cooperation to other trades and shall furnish any and all information necessary to permit the work of other trades. Information to be provided by the Contractor includes, but is not limited to templates, patterns, setting plans, and shop details as may be necessary for the proper installation of work and for the purpose of coordinating adjacent work. Information required by other trades shall be provided in a timely manner and shall be sufficient to allow the work of such other trades to proceed with the least possible interference or delay.

Where the work of the Contractor will be installed in close proximity to, or may interfere with work of other trades, the Contractor shall assist in working out space conditions to make a satisfactory adjustment. **If the Contractor installs his work before coordination with other trades, he shall make the necessary changes in his work to correct the condition without extra charge.**

Scaled Shop Drawings: If so directed by the A-E, the Contractor shall prepare composite working drawings and sections at a suitable scale not less than 3/8"=1'-0", clearly showing how his work is to be installed in relation to the work of other trades.

SAFETY REQUIREMENTS

All systems shall be installed so as to operate in a safe manner; all moving parts shall be covered where there is any possibility of danger from such moving parts. All rough edges of equipment and materials shall be made smooth.

All safety controls shall be checked under the supervision of the Owner's representative and two (2) copies of test data showing setting and performance of safety controls shall be submitted to the A-E by the Contractor.

During the construction the Contractor shall keep the site reasonably clean of debris and upon completion of construction he shall clean up the premises to remove all evidence of his work. The Contractor shall provide, at no additional cost to the Owner, additional cleaning of the site as directed by the Owner. In addition, upon completion of construction, he shall clean, wash and/or polish all fixtures, equipment and exposed material and leave each item clean, bright, and without blemish. Damaged items shall be replaced or repaired in a manner satisfactory to the Owner by the Contractor at no additional cost to the Owner.

It shall be the responsibility of the Contractor to maintain a safe working environment at all times and to comply with all OSHA regulations for the duration of the project.

SUBMITTALS

Submittals shall be made in strict accordance with the requirements of Section 019913. Specific submittal requirements are defined in each section of this Division.

Manufacturer's Data: Submit manufacturer's technical product data.

NAMEPLATE DATA

Each item of electrical utilization equipment shall be provided with a permanent operational data nameplate that shall, as a minimum, indicate the following: equipment manufacturer, product name, model number, serial number, capacity, voltage requirements, and either full load current or full load volt-amperes. Labels of tested compliances and similar essential data shall be a part of this label or located nearby. All equipment nameplates shall be in an accessible location.

In the event that the installation of equipment renders the manufacturer's nameplate inaccessible, the above information shall be etched onto a laminated plastic nameplate securely fastened to the equipment by no less than two machine screws or by other fastening methods approved by the A-E.

FLASH PROTECTION WARNING

Each piece of new electrical equipment, such as switchboards, parallel switchgear, panelboards, circuit breaker enclosures, control panels, motor control centers, transfer switches, etc. that are likely to require examination, adjustment, servicing or maintenance while energized, shall be field marked in a clearly visible location on the equipment enclosure to warn qualified persons of potential electric arc flash hazards, in accordance with NEC 110.16.

ACCESSIBILITY

Contractor shall be responsible for the sufficiency of the size of shafts and chases and the adequate clearance in double partitions and hung ceilings for the proper installation of his work. He shall cooperate with all other trades whose work is in the same place and shall advise the General Contractor of his requirements. Such spaces and clearances shall be kept to the minimum size required for such installations.

Contractor shall locate all equipment that must be serviced, operated, or maintained in fully accessible positions and shall coordinate with other trades as necessary to meet the workspace requirements of the National Electrical Code. Equipment where such space is required includes switchboards, motor control centers, panelboards, fire alarm control panels, telephone and data terminal panels and cabinets, and similar items.

Minor deviations from Drawings may be made to allow improved accessibility. Submit requests for all changes to the A-E for approval. Relocation of equipment, should such be required to meet NEC workspace requirements, shall be made by the Contractor at no additional cost.

CONCEALED RACEWAY

In general, all raceway or cable wiring methods in finished spaces shall be run concealed in walls, partitions, structural concrete panels, or above ceilings.

Exterior Raceway: Raceway may not be routed on exterior surfaces of the building or across a building roof (either above, below, or within roof insulation) unless specifically indicated on the Drawings.

Raceway Below Concrete Floor Slabs: Raceway may not be routed below concrete floor slabs unless such is specifically shown on the Drawings.

Concealment of raceway and covering of same shall not be done until authorized by the Authority Having Jurisdiction (AHJ). This applies to all interior work and exterior work.

SLEEVES AND PLATES

Contractor shall provide and locate all sleeves and inserts required, or shall be responsible for the cost of cutting and patching required where sleeves and/or inserts were not installed, or where incorrectly located. The Contractor shall be responsible for all drilling required for the installation of his hangers.

Sleeves shall be provided for all raceway passing through concrete, masonry, or tile wall, floor, or overhead deck construction. Sleeves shall be constructed of Schedule 40 black steel pipe unless otherwise indicated on Drawings. Sleeves through concrete beams shall be constructed as indicated on Drawings.

Fasten sleeves securely in walls so that they will not become displaced when other construction is built around them. Take precautions to prevent concrete, plaster, or other materials being forced into the space between raceway and sleeve during construction.

Escutcheon plates shall be provided for all exposed (where permitted) raceway passing through walls and ceilings. Plates shall be nickel plated, of the split ring type, of size to match the raceway. Where plates are provided for pipes passing through sleeves that extend above the floor surface, provide deep recessed plates to conceal the pipe sleeves.

SUPPORTS, ATTACHMENTS

Contractor shall furnish and install all necessary supports required for all electrical equipment, lighting fixtures, raceway, outlet boxes, panelboards, generators, and for all other equipment furnished under this contract, and shall submit drawings to the A-E for approval before purchase, fabrication, or construction of same.

All equipment, unless otherwise shown, shall be securely attached to the building structure in an approved manner. Attachments shall be of a strong and durable nature; any attachments that are deemed by the A-E to be insufficient due to reasons of strength, location, quality, or appearance shall be replaced as directed at no additional cost to the Owner.

Framing members shall be standard rolled steel shapes, ASTM A36 steel, except that members welded to main structural member shall be of the same specification as the main structural member.

Framing shall be "simple beam" type with end connections welded or bolted for shear loads. Cantilevers may be used when detailed or specifically approved. Location of supplementary framing shall be subject to approval. Welding, where required, shall be performed by certified welders.

Framing members shall be designed for their actual loads with allowable stresses set forth in the AISC Specifications and the AISC Code, without excessive deflection and with consideration for rigidity under vibration, in accordance with standard structural practices. Supplementary framing, including design loads, member size and location shall be clearly shown on shop drawings.

When supplementary framing is indicated, verify that dimensions are suitable and that framing is structurally adequate for the equipment furnished.

FIRE RATED CONSTRUCTION

The fire rating of all floors, ceilings, and partitions shall be maintained. It is the responsibility of this Contractor provide and install any necessary fire resistive components so that the fire integrity of all fire rated structures supporting or containing items required under Divisions 26-28 will not be diminished by the installation of such items. Where device or junction boxes penetrate any fire rated structure, the boxes shall be located in such a manner as not to reduce the fire rating of the structure. Where the Drawings indicate adjacent boxes or devices in rated partitions that would reduce the fire rating of the partition if unprotected, suitable Listed protection methods shall be used to insure the fire rating of the partition will not be decreased by the proximity of other boxes or penetrations.

Where recessed fixtures are used in fire rated ceilings, suitable construction shall be installed above and around the fixture so that the fire rating of the ceiling is maintained. Refer to Architectural Drawings for fire ratings of ceilings.

Where recessed panelboards, recessed cabinets, or other items are located in a fire rated partition, suitable construction behind and around the item shall be used to maintain the fire rating of the partition.

Where fire resistive insulation or other coverings have been applied to a structure or to structural elements to obtain a fire rating and this insulation or covering is removed or otherwise disturbed by the installation of Division 26-28 components or other related items, this Contractor shall be responsible for restoring the material to a condition that matches the original fire protective ability.

Approval must be obtained from the A-E before any boxes, devices, or other components are relocated for the purpose of maintaining fire ratings.

TESTING LABORATORY APPROVAL

All equipment shall be approved for the intended use and shall be Labeled or Listed. In any case where the suitability for a particular application is in question by the A-E or inspection authorities the Contractor shall furnish appropriate standards covering the specific piece of equipment in question. Such standards, if required, shall be requested by the A-E in writing and shall be furnished by the Contractor at no additional cost.

PERSONNEL GROUND FAULT PROTECTION

Personnel ground fault protection is to be provided for certain receptacles as indicated on the Drawings and/or as required by the National Electrical Code. Protection is to be provided by the use of GFCI receptacles; the use of GFCI circuit breakers is not acceptable for the protection of general use receptacles. GFCI receptacles may not be used to protect other downstream non-GFCI receptacles unless specifically indicated on the Drawings.

If required, use GFCI circuit breakers to protect equipment or dedicated receptacles in locations as indicated on Drawings or panel schedules. GFCI receptacles may not be used to protect downstream circuit components.

TYPICAL MOUNTING HEIGHTS OF DEVICES

Typical mounting heights for electrical equipment shall be as follows unless otherwise noted on Drawings:

DEVICE	MOUTING HEIGHT ABOVE FINISHED FLOOR (AFF)	TO
Panelboards	6'-6"	Top
Toggle Switches	3'-6"	Center Line
Receptacles	1'-6"	Center Line
Telephone Outlets	1'-6"	Center Line
Telephone Cabinets	6'-6"	Top
Telephone Backboards	6'-6"	Top
Safety Switches	5'-6"	Top
Data Outlets	1'-6"	Center Line

SCAFFOLDING, RIGGING, HOISTING

The Contractor shall furnish all scaffolding, rigging, hoisting and related sub-contract services necessary for equipment delivery and final placement as indicated on the Drawings.

All scaffolding, rigging and hoisting equipment shall be removed from the job site in a timely manner when such equipment is no longer required.

EARTHWORK

Excavating and backfilling inside and outside the building shall include shoring and bracing, pumping and protection for safety of persons and property. Backfill shall be compacted in layers not exceeding 6" in depth. Completed backfill shall conform to surrounding ground and finish grade. Restore any sidewalks, roads, or existing work which is cut or damaged to "as found" conditions. Dispose of excess material in a manner approved by the A-E at no additional cost to the Owner.

The Drawings for this project show anticipated underground utilities at locations where they will not interfere with proposed construction. Information on the Drawings concerning existing utilities or other underground services is believed to be accurate and is presented in good faith. Exact locations for such services may be determined only by excavation; extreme caution shall be used with regard to trenching or excavation in the vicinity of underground services. In trenching or other excavation work always assume the presence of undocumented underground services. In the event underground services are damaged by the Contractor the Contractor shall repair same in a manner satisfactory to the A-E at no additional cost to the Owner. Contractor shall employ a third party locating service prior to any excavation work.

ELECTRICAL CIRCUITS

Circuit designations and connections are shown on the Drawings. Indicated circuit numbers and circuit breaker positions are mandatory unless changes are specifically approved by the A-E in writing.

Electrical neutral connections are indicated on the Drawings. Neutrals may not be reconfigured or otherwise changed without specific approval in writing from the A-E.

Request for circuit or neutral changes **can not be a part of the equipment submittal process.**

EQUIPMENT CONNECTIONS

In general, provide complete electrical power supply system connections to all equipment shown on Drawings. In addition, provide disconnection and re-connection to the power system of any items that are indicated on the Drawings as being moved or relocated.

Control wiring shall be installed in raceways and box system separate from power wiring, unless otherwise indicated on Drawings. Wiring within equipment enclosures shall be in raceways provided under this section of the Specifications unless approved raceway is provided by the manufacturer of the equipment or unless the equipment is listed for use as a raceway.

ELECTRICAL PROVISIONS FOR DIVISIONS 21 - 23

Division 26-28 Contractor shall provide complete power wiring to a disconnecting means provided under Division supplying the equipment. Extension of power from the disconnecting means to the utilization equipment shall be made under the Division supplying the equipment.

Starters, contactors, and similar control equipment shall be furnished and installed by other divisions unless specifically shown on the electrical Drawings. Control wiring is furnished by the Division supplying the control equipment.

Fuses for fused disconnects are furnished and installed by the division supplying the equipment to be protected.

Refer to Sections 210511, *ELECTRICAL PROVISIONS FOR FIRE PROTECTION WORK,* 220511, *ELECTRICAL PROVISIONS FOR PLUMBING WORK* and/or 230511, *ELECTRICAL PROVISIONS FOR HVAC WORK* for a complete description and breakdown of the responsibility of each trade (Divisions 20-23 and Divisions 26-28).

END OF SECTION 260500

SECTION 260519 - SECONDARY VOLTAGE WIRES AND CABLES

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Manufacturers: Firms regularly engaged in manufacture of electrical products, of types and ratings required in this Section, whose products are Listed and Labeled for the purpose intended. Subject to compliance with requirements provide devices equivalent to one of the following:

Encore Wire Corporation
General Cable Corporation
Southwire Company
Cerro Wire

Codes and Standards:

NEC Compliance: Comply with NEC requirements as applicable to construction, installation and color coding of electrical wires and cables.

Testing Laboratory Compliance: Provide wiring/cabling and connector products that are Listed and Labeled.

SUBMITTALS

Submittals shall be made in strict accordance with the requirements of Section 019913. Specific submittal requirements are defined in each section of this Division.

Product Data: Submit manufacturer's data on electrical wires, cables and connectors.

PART 2 - PRODUCTS

SECONDARY VOLTAGE WIRES, CABLES, AND CONNECTORS

General: Provide electrical wires, cables, and connectors of manufacturer's standard materials, as indicated by published product information. Connections shall be designed and constructed using connectors as recommended by manufacturer for a complete installation for the application indicated. Provide copper conductors with conductivity of not less than 98% at 68° F.

Building Wires: Provide factory-fabricated wires of sizes, ampacity ratings, and materials for applications and services indicated. Where not indicated, provide proper wire selection as determined by Contractor to comply with project's installation requirements, NEC and NEMA standards. Select from the following Listed types those wires with construction features that fulfill project requirements:

Type THWN/THHN: For general use as interior branch circuits and feeders; maximum operating temperature 90° C (194° F). Insulation, flame-retardant, moisture- and heat-resistant, thermoplastic; outer covering, nylon jacket; conductor, annealed copper.

Type XHHW: For general use as exterior feeders and service entrance conductors, as conductors in all underground raceway, as conductors in wet locations and as specifically indicated on the Drawings; maximum operating temperature 90° C (194° F). Insulation, moisture and heat-resistant cross-linked polymer; conductor, annealed copper.

Building wire shall be installed in raceway for all applications. Cables are not approved for use in this project under Division 26.

Connectors:

General: Provide factory-fabricated, metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated. Where not indicated, provide proper selection as determined by Installer to comply with project's installation requirements, NEC and NEMA standards. Select from the following, those types, classes, kinds and styles of connectors to fulfill project requirements:

Type: Pressure, threaded

Class: Insulated

Kind: Copper (for Cu to Cu connection)

Style: Wirenut, wingnut, power distribution block

Use power distribution blocks or other splicing device having a minimum of one clamping screw per conductor where conductor size or quantity exceed limits for "wirenut" or "wingnut" type connectors.

Provide power distribution blocks that are attached to the gutter, box, or enclosure into which they are installed. Free-floating, unattached power distribution blocks are not acceptable.

Provide suitable insulating covers for all connection devices where such insulation is not a part of the device design.

Use of split bolt connectors, insulation piercing connectors, or tape as a means of insulating connection devices is not acceptable.

PART 3 - EXECUTION

INSTALLATION OF WIRES AND CABLES

General: Install wires and wiring connectors as indicated, in compliance with applicable requirements of NEC, NEMA, UL, and NECA's "Standard of Installation," and in accordance with recognized industry practices.

Coordinate wire/cable installation work including electrical raceway and equipment installation work, as necessary to properly interface installation of wires/cables with other work.

Circuits of size #8 AWG and larger shall have Class B stranded conductors.

Power and lighting circuits #10 AWG and smaller shall have solid conductors. The minimum size for all power and lighting circuits shall be #12 AWG.

Control wiring shall have stranded conductors and a minimum size of #14 AWG.

Maximum size for feeders and service conductors shall be 500 kcmil.

Increase Drawing indicated size of conductors for ampacity and temperature rating as described below:

Conductor sizes shown on Drawings are based on the use of terminations Listed and Labeled for use at 75° C. (167° F.). Where terminations are not Listed and Labeled for use at 75° C. (167° F.), the Contractor shall increase the size of the conductor as required to meet the temperature rating of the conductor in accordance with NEC Article 110.14(c). Conductor size increases required under this section shall be made without additional cost.

Increase Drawing indicated size of conductors for voltage drop as follows:

Use #10 AWG conductor for 20 Ampere, 120 Volt branch circuit home runs longer than 50 feet, unless otherwise noted on Drawings.

Use #10 AWG conductor for 20 Ampere, 277 Volt branch circuit home runs longer than 100 feet, unless otherwise noted on Drawings.

Conduit runs shall contain the number of phase conductors shown on the plans. A dedicated neutral shall be installed for each phase conductor served by single pole, 120 and 277 Volt, 20 Amp circuit breakers. Multi-pole circuit breakers serving 120 and 277 Volt, 20 Amp multi-wire branch circuits with a common neutral shall not be permitted. Conduits runs shall contain related grounding and/or isolated grounding conductors.

Conduit runs that contain more than one neutral shall have each neutral conductor uniquely identified at each termination, splice and where routed through junction or pull boxes. Neutral conductors containing a factory applied, trace line along the length that matches the color of the associated phase conductor shall be used to meet this requirement. Machine printed labels with the panel and associated circuit number shall also be permitted for identifying neutral conductors. Colored tape and pre-printed tags shall not be acceptable.

Feeders and/or branch circuits shall not be combined either with each other or one with another into junction boxes, pull boxes, device boxes, manholes, or other common routing unless such routing is specifically indicated on the Drawings.

Neatly train wiring inside boxes, equipment and panelboards; Avoid bundling conductors with lacing or cable ties so that generated heat may be more easily dissipated.

Conduit runs indicated on the Drawings as composed of parallel runs of conductors shall be made identical with respect to length, conduit size, wire type, insulation type, routing, and terminations at each end.

Conductors Shall Be Color Coded as Follows:

Grounding Conductors: Green

Isolated Grounding Conductors: Green with yellow tracer

Grounded Neutral Conductors: White for 120 V systems, gray for 277 V systems

Ungrounded Phase Conductors for 208Y/120V Systems: Black (phase A), red (phase B), and blue (phase C)

Ungrounded Phase Conductors for 480Y/277V Systems: Brown (phase A), orange, (phase B) and yellow (phase C)

Switch Leg Travelers: Violet

Provide other wire colors as indicated on the Drawings.

Remarking of insulation colors by use of colored marker tape shall be permitted only as allowed by the NEC.

Install exposed cables (where permitted) parallel and perpendicular to surfaces, or exposed structural members.

Cables shall follow surface contours, where possible.

Completely and thoroughly swab raceway system before installing conductors.

Branch circuit wiring shall not loop through receptacle terminals, but shall be connected by means of conductor taps joined to branch circuit conductors. At end of run, branch circuit conductors may terminate on receptacle screw terminals. Quick make, clamp, or push-in type terminations may not be used to make connections to devices.

Position all splices in pull boxes and junction boxes of adequate volume so they are accessible from the removable cover side of the box.

Conductors for signal systems shall be continuous (without splice) and shall be terminated on terminal strips or terminate in a manner approved by the system's manufacturer.

All neutrals and ground wires in panels shall be labeled with cloth wire markers to indicate the circuits being served.

Pull conductors simultaneously where more than one is being installed in same raceway.

Use pulling compound or lubricant, where necessary; compound used must not deteriorate conductor or insulation. After conductors have been pulled, clean exposed conductors and surrounding area to remove all evidence of the use of pulling compound.

Use pulling means including fish tape, cable, rope and basket weave wire/cable grips that will not damage cables or raceway.

Keep conductor splices to a minimum.

Install splices and taps that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.

Use splice and tap connectors that are compatible with conductor material.

Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standard 486A and B.

WIRING CONNECTIONS AND TERMINATIONS

Splices shall be permitted on conductors up to #4 AWG. No splices shall be permitted on conductor #3 AWG and larger without specific approval in writing by the A-E. Splices shall be made in accessible junction boxes; no splices shall be made in conduit bodies.

Splices, taps, and attachments of fittings and lugs shall be electrically and mechanically secure. Connectors and lugs shall be proper size and labeled as suitable for the number and type of conductors joined.

Solid conductors, namely those sized #10 and #12 AWG copper shall be spliced or tapped only by the use of Ideal "Wing-Nuts" or "Wire Nuts", Buchanan's "B-Cap" or 3M Co.'s "Scotchlox" connectors. "Sta-Kon" or other permanent type crimp connectors shall not be used.

Self-stripping electrical pigtail and tap connectors shall not be used.

Stranded conductors, namely #8 AWG to #4 AWG, shall be spliced or tapped by approved mechanical connectors. Insulation for splices or taps shall be obtained by the use of Listed insulating covers designed for use with the particular connector. Quality of insulation at splices shall equal that of the conductor insulation in terms of temperature resistance, covering ability and durability.

Conductors, in all cases, shall be continuous from outlet to outlet, and no splicing shall be made except within outlet or junction boxes, troughs, and gutters. No splices shall be permitted in panel enclosures, disconnects or utilization equipment.

Lugs for conductors #8 through #4 AWG shall be copper, with a direct acting screw. Where permitted, lugs for conductors #3 AWG and larger shall be copper, applied directly to the cable by hydraulic pressure. Lugs shall not be split bolt or screw types.

Tape, where used, shall be made using special oil resistant vinyl plastic tape that is Listed, rated 105° C.

Splices or taps in grounding conductors (where permitted) in sizes #8 AWG and larger shall be by means of exothermic welding and termination shall be by means of approved grounding connectors. As an alternate, connectors using hydraulic compression tools may be used as a contractor selection option. Solder shall not be used as a means of joining grounding conductors.

Thoroughly clean wires before installing lugs and connectors.

Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.

Terminate spare conductors with electrical tape.

FIELD QUALITY CONTROL

Prior to energizing circuitry, check installed wires and cables with megohm meter to determine insulation resistance levels to insure requirements are fulfilled. Provide additional testing as directed by the A-E in accordance with Section 260800, *TESTING AND PLACING IN SERVICE*.

Prior to energizing circuitry, test wires and cables for electrical continuity and for short circuits. Verify proper phasing connections.

Subsequent to wire and cable hook-ups, energize circuitry and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

END OF SECTION 260519

SECTION 260526 - GROUNDING

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacture of grounding and bonding products, of types, and ratings required, and ancillary grounding materials, including stranded cable, grounding rods, and bonding jumpers whose products are Listed and Labeled for their intended usage.

Codes and Standards:

Electrical Code Compliance: Comply with applicable State electrical code requirements and the authority having jurisdiction, and NEC as applicable to electrical grounding and bonding, pertaining to systems, circuits and equipment.

Testing Laboratory Compliance: Comply with applicable requirements of UL Standards No.'s 467, "Electrical Grounding and Bonding Equipment," and 869, "Electrical Service Equipment," pertaining to grounding and bonding of systems, circuits and equipment. In addition, comply with UL Std. 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors." Provide grounding and bonding products that are Listed and Labeled for their intended usage.

IEEE Compliance: Comply with applicable requirements of IEEE Standard 142 and 241 pertaining to electrical grounding.

SUBMITTALS

Submittals shall be made in strict accordance with the requirements of Section 019913. Specific submittal requirements are defined in each section of this Division.

Product Data: Submit manufacturer's data on grounding and bonding products and associated accessories.

PART 2 - PRODUCTS

GROUNDING AND BONDING SYSTEMS

Materials and Components:

General: Except as otherwise indicated, provide electrical grounding and bonding systems indicated, assemble materials, including, but not limited to, cables/wires, connectors, solderless lug terminals, grounding rods, bonding jumpers, service arresters, and additional accessories as needed for a complete installation. Where more than one type component product meets indicated requirements, selection is Contractor's option. Where materials or components are not indicated, provide products that comply with NEC and UL requirements and with established industry standards for those applications indicated.

Conductors: Unless otherwise indicated, provide equipment grounding conductors in all conduit and wiring systems. Grounding conductors shall be insulated by the same type insulation as the ungrounded conductors and sized in accordance with NEC Table 250.122 unless otherwise specified.

Bonding Connectors, Terminals and Clamps: Provide electrical bonding connectors, terminals, lugs and clamps as recommended by bonding connector, terminal and clamp manufacturers for indicated applications.

Ground Rods: Provide rods made of steel with copper welded exterior, 3/4" diameter by 10 feet.

Ground Bus Bars: Provide copper bus bars mounted on standoff insulating bushings.

Hardware: Provide hardware for all grounding and bonding applications that consist of Type 300 series stainless steel, silicon bronze or brass. Hardware used for connections to enclosures shall include flat washers and split lock washers.

Electrical Grounding Connection Accessories: Provide electrical insulating tape, bonding straps, as recommended by accessories manufacturers for type service indicated.

PART 3 - EXECUTION

EXAMINATION

Examine areas and conditions under which electrical grounding and bonding connections are to be made and notify A-E in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

INSTALLATION OF ELECTRICAL GROUNDING AND BONDING SYSTEMS

General: Install electrical grounding and bonding systems as indicated, in accordance with manufacturer's instructions and applicable portions of NEC, NECA's "Standard of Installation," and in accordance with recognized industry practices to ensure that products comply with requirements.

Install grounding systems as designed and submit certified test report on grounding system.

Coordinate with other electrical work as necessary to interface installation of electrical grounding and bonding system work with other work.

Ground electrical service system neutral at service entrance equipment to grounding rod(s), grounded copper water pipe, and building steel where effectively grounded. All ground corrections shall be accessible. Provide additional bonding connections to miscellaneous metallic piping systems entering the building such as fire protection and gas piping.

Provide an intersystem ground bus bar adjacent service equipment as shown on the drawings.

Ground each separately-derived system neutral to:

Effectively grounded copper water pipe

Building structural steel

Connect together system neutral, service equipment enclosures, exposed noncurrent carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and cold water systems.

Install direct burial type ground clamps for grounding electrode conductors to underground grounding rods.

Provide a separate, insulated equipment grounding conductor from each device to ground buses in panelboards. Terminate each end on a grounding lug, bus, or insulated grounding bushing.

Provide separate insulated equipment grounding conductor, size to be determined from NEC Table 250.122, for each circuit and in each conduit run. The grounding conductor shall be attached by means of a dedicated green screw to a common point in each junction box, cabinet, device box, enclosure, or utilization equipment to which it runs or through which it passes. Grounding methods depending on the continuity of electrical raceway, clips, or mounting screws are not acceptable. This grounding requirement will be rigidly enforced.

Connect grounding electrode conductors to copper water pipe using a suitable grounding clamp as indicated on drawings. Provide conduit grounding hubs and water pipe ground clamps as required.

Provide copper grounding conductor from supplemental ground bus bar adjacent service equipment to communications (telephone/data or cable TV) backboards where shown on drawings. Terminate conductor on insulated ground bus bar for use by others.

Provide an insulated bonding bushing on all panelboard feeders. Terminate feeder equipment grounding conductor by passing the conductor through the terminal of the insulated bonding bushing and then onward to terminate at the panel ground bus.

Provide an insulated bonding bushing at boxes, enclosures or cabinets with concentric, eccentric or over-sized knockouts. Terminate equipment grounding conductor by passing the conductor through the terminal of the insulated bonding bushing and then onward to terminate at ground bus or lug.

Connect grounding electrode conductors to 1-inch diameter, or greater, metallic cold water pipe using a suitably sized ground clamp.

Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.

Apply corrosion-resistant finish to field-connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed.

Install clamp-on connectors on clean metal contact surfaces to ensure electrical conductivity and circuit integrity.

Sectionalizing switchgear housing, cable shielding and primary grounding conductors shall be connected to a driven copper ground rod having a maximum resistance of 25 Ohms by means of # 3/0 AWG bare copper stranded conductor.

Service transformer housing, cable shields, primary and secondary neutrals shall be connected to a driven copper ground having a maximum resistance of 25 Ohms using # 3/0 AWG bare stranded copper conductor. Primary neutral conductor shall be unbroken to transformer primary neutral bushing, and thereafter grounded as indicated on the Drawings.

FIELD QUALITY CONTROL

Upon completion of installation of electrical grounding and bonding systems, test ground resistance with ground resistance tester. Where tests show resistance-to-ground is over 25 Ohms, take appropriate action to reduce resistance to 25 Ohms, or less, by driving additional ground rods; then retest to demonstrate compliance.

Provide written certified testing report indicating resistance-to-ground value.

END OF SECTION 260526

SECTION 260529 - SUPPORTING DEVICES

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification section, apply to work of this section.

QUALITY ASSURANCE

Manufacturers: Firms regularly engaged in manufacture of supporting devices, of types, sizes, and ratings required.

Codes and Standards:

NEC Compliance: Comply with NEC requirements as applicable to construction and installation of electrical supporting devices.

Testing Laboratory Compliance: Provide electrical components that are Listed and Labeled.

ANSI Compliance: Comply with ANSI/MSS SP-69, Hangers and Supports – Selection and Application for selecting electrical supporting devices.

SUBMITTALS

Submittals shall be made in strict accordance with the requirements of Section 019913. Specific submittal requirements are defined in each section of this Division.

Product Data: Submit manufacturer's data on supporting devices including catalog cuts, specifications, and installation instructions, for each type of support, anchor, sleeve and seal.

PART 2 - PRODUCTS

MANUFACTURED SUPPORTING DEVICES

General: Provide supporting devices as herein specified which comply with manufacturer's standard materials, design and constructed in accordance with published product information and as required for complete installation. Where more than one type of supporting device meets indicated requirements, selection is Installer's option.

Supports: Provide supporting devices of types, sizes and materials indicated that have the following construction features:

Clevis Hangers: For supporting large rigid metal conduit hangers shall be steel with finish appropriate for application and 1/2" diameter hole for round steel rod. Approximate weight is 54 pounds per 100 units.

Reducing Couplings: Steel rod reducing coupling shall be 1/2", 3/8" or ¼" x 5/8" steel, with finish appropriate for application.

C-Clamps: C-clamps shall be ductile iron, with finish appropriate for application and 1/2", 3/8" or ¼" rod size. Approximate weight is 50 pounds per 100 units.

I-Beam Clamps: I-beam clamps shall be steel, with finish appropriate for application. 1-1/4" x 3/16" stock with 3/8" cross bolt. Flange width shall be 2". Approximate weight is 52 pounds per 100 units.

Conduit Hangers: Hangers shall be galvanized steel used for supporting conduit up to 2". Weight varies with conduit size, up to 25 pounds per 100 units for 2" trade size.

One-Hole Conduit Straps: One hole conduit straps used for supporting 1/2" conduit (where such is permitted) and 3/4" conduit, shall be galvanized steel. Approximate weight is 7 pounds per 100 units.

Two-Hole Conduit Straps: Two hole conduit straps, used for supporting conduit larger than 3/4", shall be galvanized steel. Weight varies with conduit size.

Hexagon Nuts: For 1/2", 3/8" or ¼" rod sizes, nuts shall be galvanized steel.

Round Steel Rod: Use black steel for 1/2", 3/8" or ¼" diameter rod.

Anchors: Provide anchors of types, sizes and materials indicated, with the following construction features:

Lead Expansion Anchors: 1/2", approximately 38 pounds per 100 units.

Toggle Bolts: Springhead type, 3/16" x 4", approximately 5 pounds per 100 units.

Powder actuated anchors and fasteners are not permitted.

Watertight Wall and Floor Seals: Provide factory-assembled watertight wall and floor seals of types and sizes indicated. Wall and floor seals shall be suitable for sealing around conduit, pipe, or tubing passing through concrete walls. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws.

U-Channel Strut Systems: Provide U-channel strut system for supporting electrical equipment and conduit where runs of more than two conduit must be supported from overhead structure. System shall be 12-gage minimum hot-dip galvanized steel of types and sizes indicated. Use 1 1/2" deep channel to support conduit larger than 1 1/2" trade diameter. Furnish with the following fittings that mate and match with U-channel:

Channel hangers

End caps

Beam clamps

Wiring studs

Thinwall conduit clamps

Rigid conduit clamps

Conduit hangers

U-bolts

FABRICATED SUPPORTING DEVICES

Pipe Sleeves: Provide pipe sleeves as follows:

Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.

Sleeve Seals: Provide sleeves for piping which penetrates foundation walls below grade, or exterior walls. Caulk between sleeve and pipe with non-toxic, UL classified caulking material to ensure watertight seal.

PART 3 - EXECUTION

INSTALLATION OF SUPPORTING DEVICES

Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NECA and NEC for installation of supporting devices.

Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

Install hangers, supports, clamps and attachments to support conduit properly from building structure. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible. Install supports with spacings indicated and in compliance with NEC requirements.

Torque sleeve seal nuts, complying with manufacturer's recommended values. Ensure that sealing grommets expand to form water tight seal.

END OF SECTION 260529

SECTION 260533 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Manufacturers: Firms regularly engaged in manufacture of electrical identification products, of types required.

Codes and Standards:

NEC Compliance: Comply with NEC as applicable to installation of identifying labels and markers for wiring and equipment.

UL Compliance: Comply with applicable requirements of UL Std. 969, "Marking and Labeling Systems," pertaining to electrical identification systems.

NEMA Compliance: Comply with applicable requirements of NEMA Std. No's. WC-1 and WC-2 pertaining to identification of power and control conductors.

SUBMITTALS

Submittals shall be made in strict accordance with the requirements of Section 019913. Specific submittal requirements are defined in each section of this Division.

Product Data: Submit manufacturer's data on electrical identification materials and products.

Label Wording: Submit exact wording for approval prior to the construction of laminated nameplates or specialized signs. Submittal shall show both proposed wording and physical layout of each label, including mounting holes.

PART 2 - PRODUCTS

ELECTRICAL IDENTIFICATION MATERIALS

General: Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option, but provide single selection for each application.

Engraved Plastic-Laminate Signs:

General: Provide engraving stock melamine plastic laminate, in sizes and thicknesses indicated, engraved with engraver's standard letter style of sizes and wording indicated or as required to properly identify items installed under this division.

Color scheme shall be as indicated herein or on the Drawings. Signs shall be punched for mechanical fastening.

Thickness: 1/16", for units up to 20 sq. in. or 8" length; 1/8" for larger units.

Fasteners: Self-threading, blunt end, stainless steel machine screws.

Color-Coded Plastic Tape:

General: Provide manufacturer's standard self-adhesive vinyl tape not less than 3 mils. thick by 1-1/2" wide. Tape shall be listed for use at 105°C. or the temperature rating of the conductors to be marked, whichever is higher.

Cable/Conductor Identification Bands:

General: Provide pre-numbered or pre-lettered manufacturer's standard cloth self-adhesive cable/conductor markers of wrap-around type. Printing shall show circuit identification by indicating panel designation and circuit number.

Underground Type Plastic Line Marker:

General: Manufacturer's standard permanent, bright colored, continuous printed plastic tape, intended for direct burial service, not less than 6" wide x 4 mils thick. Provide electrically conductive tape with printing which most accurately indicates type of service of buried conduit or cable.

Place line marker 6" to 8" below finished grade and directly above line to be protected. For multiple conduit or cable runs in the same trench, use multiple line markets, one above each conduit or cable.

Baked Enamel Danger Signs:

General: Provide manufacturer's standard "DANGER" signs of baked enamel finish on 20-gage steel. Signs shall be of standard red, black and white graphics, 14" x 10" size. Where larger size exceeds space available, the 10" x 7" size may be used. Signs shall have recognized standard explanation wording, such as, “HIGH VOLTAGE,” “KEEP AWAY,” “BURIED CABLE,” “DO NOT TOUCH SWITCH,” etc.

Code-Colored Conduit Markers:

General: Provide manufacturer's standard pre-printed, flexible or semi-rigid, permanent, plastic-sheet conduit markers, for feeders extending 360 degrees around conduits. Markers shall be designed for attachment to conduit by adhesive, adhesive lap joint of marker, matching adhesive plastic tape at each end of marker, or pre-tensioned snap-on. Except as otherwise indicated, provide lettering that indicates voltage of conductor(s) in conduit. Provide 8" minimum length for 2" and smaller conduit, 12" length for larger conduit.

Colors: Unless otherwise indicated on the Drawings or required by governing regulations, provide white markers with black letters.

LETTERING AND GRAPHICS

General: Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturer or as required for proper identification and operation/maintenance of electrical systems and equipment.

WIRE COLOR CODE SCHEDULE

Where more than one nominal voltage system exists within a single facility, a schedule of conductor color codes shall be posted at each panelboard that is installed, relocated, renovated, or otherwise modified. The schedule, meeting the requirements of NEC 210.5(C) for branch circuit panelboards, shall be permitted to be either a plastic laminate sign or a printed label with permanent self-adhesive containing the information given in Section 260519, *SECONDARY VOLTAGE WIRES AND CABLES*. The label shall be installed so that it is clearly visible with the panelboard cover removed but with any shields or protective barriers in place. The label shall be installed after the installation of all conductors so that it may be located in an un-obscured location.

SERVICE EQUIPMENT AVAILABLE FAULT CURRENT LABEL

Based on the short circuit study conducted by the engineer for the distribution system, the Contractor shall prepare a phenolic field label to identify the available fault current at service equipment. This label shall be consistent with the requirements of this Section, with respect to color scheme and size. The label shall clearly indicate the date in which the calculation was prepared, as indicted by the engineer.

PART 3 - EXECUTION

APPLICATION AND INSTALLATION

General Installation Requirements:

Install electrical identification products as indicated, in accordance with manufacturer's written instructions, and requirements of NEC.

Coordination: Where identification is to be applied to surfaces that require finish, install identification after completion of painting.

Regulations: Comply with governing regulations and requests of governing authorities for identification of electrical work.

Conduit and Box Identification:

General: Apply color-coded identification to match system color code on electrical conduit and junction boxes in accordance with the following:

All empty conduit runs and conduit with conductors for future use shall be identified for such use; identification shall indicate where such conductors or empty conduct terminates. Identification shall be by tags attached to the pull cord or spare conductors. Each end of the pull cord shall be identified.

All outlet boxes, junction boxes and pull boxes, either exposed or concealed, shall have their covers and exterior visible surfaces painted with the field colors described in this section. Boxes shall also be marked to indicate the panelboard and circuit number(s) of the circuits contained within. Lettering may be by hand for concealed or non-public locations only. Machine printed labels are to be used to identify boxes where such are permitted to appear in areas accessible by the public; embossed type plastic labels are not acceptable for use on this project. Where hand produced marking is permitted, the lettering shall be made with waterproof ink.

Where raceways (feeder and branch circuits) are exposed and part of the emergency branch (NEC 700), provide permanent labeling at intervals not to exceed 25'. Reference NEC 700.10.

Equipment/System Identification:

General: Install an engraved plastic laminate sign on each major unit of electrical equipment on project. Such equipment includes central or master unit of each electrical system including communication, control, and signal systems, unless unit is specified with its own self-explanatory identification. Except as otherwise indicated, provide single line of text, 1/2" high lettering, on 1-1/2" high sign (2" high where 2 lines are required), white lettering in field color as indicated below. Provide text matching terminology and numbering of the Contract Documents and shop drawings.

Field Colors shall be the following:

Blue surface with white core for 120/208 Volt equipment.
Black surface with white core for 277/480 Volt equipment.
Bright red surface with white core for all equipment related to fire alarm system.
Dark red (burgundy) surface with white core for all equipment related to security.
Green surface with white core for all equipment related to emergency systems.

Yellow surface with black core for all equipment related to optional stand-by systems.
Yellow surface with red core for all equipment related to legally required stand-by systems.
Orange surface with white core for all equipment related to telephone systems.
Brown surface with white core for all equipment related to data systems.
White surface with black core for all equipment related to paging systems.
Purple surface with white core for all equipment related to TV systems.

Provide Signs for Each Unit of the Following Categories of Electrical Work:

Delete items that are not used on this project.

Panelboards, electrical cabinets and/or enclosures
Switchgear
Disconnect or safety switches
Telephone terminal cabinets
Pushbuttons
Contactors
Transformers
Fire alarm master stations

Service Equipment:

Where multiple services exist in a building provide a phenolic sign per NEC 230.2(E) at all service locations (new or existing).

Install signs at locations for best convenience of viewing without interference with operation and maintenance of equipment. Secure signs to substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate substrate.

Cable/Conductor Identification (Low Voltage):

General: Apply cable/conductor identification, including feeder number, on each cable/conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present, except where another form of identification (such as color-coded conductors) is provided. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project's electrical work.

Cable/Conductor Identification (High Voltage):

General: Apply cable identification, including feeder number and phase identification, on each cable in each box, manhole, handhole, enclosure, and/or cabinet where high voltage cables are present. Use of color coded tape to identify phases is acceptable provided this identification is accompanied by feeder identification attached to each cable.

Match identification with marking system used elsewhere in the Contract Documents. Identification means used on high voltage cables shall be waterproof and shall not deteriorate when used in a wet environment.

Underground Cable Identification:

General: During backfilling/top soiling of each exterior underground conduit, install continuous underground type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Install line marker for all buried conduits.

Optional Identification and Warnings:

General: Install self adhesive plastic signs or similar equivalent identification wherever reasonably required to prevent misuse by unauthorized personnel or to ensure safe and efficient operation and maintenance of electrical systems, electrically connected mechanical systems, and general systems and equipment. Install self-adhesive plastic signs or similar equivalent identification giving instruction or warnings on switches, outlets, controls, or devices where instructions or explanations are needed. Provide plasticized tags with clearly written messages adequate for intended purposes.

END OF SECTION 260533

SECTION 260534 - RACEWAYS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 specification sections, apply to work of this section.

QUALITY ASSURANCE

Manufacturers: Firms regularly engaged in manufacture of raceway systems of types and sizes required, whose products are Listed and Labeled.

Codes and Standards:

NEMA Compliance: Comply with applicable requirements of NEMA Standards Publications pertaining to raceways.

Testing Laboratory Compliance and Labeling: Comply with applicable requirements of UL safety standards pertaining to electrical raceway systems. Provide raceway products and components that have been Listed and Labeled.

NEC Compliance: Comply with applicable requirements of the latest edition of the NEC pertaining to construction and installation of raceway systems.

SUBMITTALS

Submittals shall be made in strict accordance with the requirements of Section 019913. Specific submittal requirements are defined in each section of this Division.

Product Data: Submit manufacturer's technical product data, including specifications and installation instructions, for each type of raceway system required. Include data substantiating that materials comply with requirements.

PART 2 - PRODUCTS

METAL CONDUIT AND TUBING

General: Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) for each use indicated. Where types and grades are not indicated, provide proper selection determined by Installer to fulfill wiring requirements as stated herein while complying with applicable portions of NEC for raceways.

Rigid Metal Conduit (RMC): Provide rigid steel, zinc-coated, threaded type conforming to ANSI C80.1 and UL 6. Provide zinc coating fused to inside and outside walls.

Intermediate Metal Conduit (IMC): Provide rigid intermediate grade hot-dip galvanized type conforming to UL 1242.

Electrical Metallic Tubing (EMT): Provide electrical metallic conduit conforming to ANSI C80.3 and UL 797.

Flexible Metal Conduit (FMC): Provide steel flexible metal conduit conforming to UL 1. Conduit shall be formed from continuous length of spirally wound, interlocked zinc-coated strip steel.

Liquid-Tight Flexible Metal Conduit (LFMC): Provide flexible liquid-tight metal conduit constructed of single strip, flexible, continuous, interlocked, and double-wrapped steel. Inside and outside shall be galvanized; conduit shall be coated with liquid-tight jacket of flexible polyvinyl chloride (PVC).

Rigid Metal Conduit Fittings: Provide cast malleable iron, galvanized or cadmium plated.

Use Type 1 fittings for raintight connections.
Use Type 2 fittings for concrete tight connections.

Conduit Locknuts: Provide case-hardened steel locknuts for use on threaded raceway.

Conduit Bushings:

Insulated: Provide Listed and Labeled, threaded, thermosetting plastic bushings at each end of all threaded raceway. Provide grounding type if same is indicated elsewhere.

Grounding (bonding type): Provide Listed and Labeled, threaded, insulated throat, bonding type bushings. Provide steel frame bushings for use on ferrous raceway. Provide bushings with tin-plated copper grounding saddle sized to accept grounding conductor size as indicated on the Drawings. Where grounding conductors are oversized, provide separate copper grounding lugs that are appropriately sized.

Flexible Metal Conduit Fittings: Provide steel conduit fittings for use with flexible steel conduit of threadless hinged clamp type. All flexible metal conduit fittings shall be Listed as suitable for grounding.

Straight Terminal Connectors: Provide insulated throat type, one piece body, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provided with steel locknut.

45° or 90° Terminal Angle Connectors: Provide steel insulated throat type, two-piece body construction with removable upper section, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provided with steel locknut.

Liquid-Tight Flexible Metal Conduit Fittings: Type 1, Class 3, Style G. Provide cadmium plated, malleable iron fittings with compression type steel ferrule and neoprene gasket sealing rings, with insulated throat and steel locknut. All liquid tight flexible metal conduit fittings shall be Listed as suitable for grounding.

EMT Fittings:

EMT Conduit Couplings: Cadmium plated steel, dual compression type with two (2) hexagon compression fittings. Fittings that can not be tightened with an open-end wrench of the appropriate size are not acceptable.

EMT Conduit Connectors: Cadmium plated steel, insulated throat, compression type with hexagon compression fitting and steel locknut. Fittings that can not be tightened with an open-end wrench of the appropriate size are not acceptable.

Unacceptable fitting types: Pot metal, set screw, and indenter type fittings, or connectors that do not have insulated throats, are not acceptable for use on this project.

Conduit Bodies: Provide galvanized steel conduit bodies of types, shapes and sizes as required to fulfill job and NEC requirements. Conduit bodies shall be constructed with threaded conduit entrance ends, removable covers, either cast or of galvanized steel, and corrosion-resistant screws.

Metallic Conduit, and Tubing Accessories: Provide metallic conduit and tubing accessories of types, sizes, and materials, complying with manufacturer's published product information, which mate and match conduit and tubing.

Conduit Seal Fittings: Provide conduit seal fittings rated for Class 1, Division 1, Group B. Seals shall have threaded connections. Provide a drain for continuous, automatic drainage of accumulated condensation. Provide listed sealing compound within fitting.

Rigid Conduit Seal Eys/EVS: Provide threaded conduit seal eys/evs of types and sizes, complying with manufacturer's published product information, which mate and match conduit. These shall restrict the passage of gases, vapors, and flames from one portion of the electrical installation to another.

SURFACE METAL RACEWAY

General: Provide galvanized steel surface metal raceways with snap-on covers of types, grades, sizes, and number of channels for each type of service as indicated. Provide complete assembly of surface metal raceways including, but not limited to, couplings, offsets, elbows, expansion joints, adapters, holddown straps, end caps, and other components and accessories as required for a complete system.

Type 1 Raceway: ½" x 5/8" two-piece assembly in lengths as indicated, furnished in standard factory tan enamel finish.

Type 2 Raceway: 3/4" x 5/8" two-piece assembly in lengths as indicated, furnished in standard factory tan enamel finish.

Boxes for Surface Metal Raceway: Provide boxes for surface metal raceway as required to match required devices and outlets. All boxes for surface metal raceway shall be designed, manufactured and supplied by raceway manufacturer for use with specified raceway.

PART 3 - EXECUTION

INSPECTION

Examine areas and conditions under which raceways are to be installed, and substrate that will support raceways. Notify A-E in writing of conditions detrimental to proper completion of the Work. Do not proceed with work until unsatisfactory conditions have been corrected.

SELECTION OF RACEWAY AND SIZE OF RACEWAY SYSTEM

General: Install concealed raceway system in new construction work, either in walls or above hung ceilings.

Do not route raceway below slabs unless such routing is specifically indicated on the Drawings.

Do not use surface metal raceway unless such use is specifically indicated on the Drawings.

Conduit Installation: Unless otherwise indicated on the Drawings, provide rigid steel zinc-coated conduit (RMC) where embedded in concrete, masonry, earth, or installed outdoors. Follow minimum requirements in other areas as follows:

Steel zinc-coated EMT may be installed in all areas except where specifically indicated otherwise in the Drawings or under the conditions of use listed below:

- Where installed in a classified area, including Class 1, Division 1 and Class 1, Division 2 locations.
- Where it will be installed in exterior walls.
- Where it will be installed outdoors, in concrete or in direct contact with the earth.
- Where it will be subject to physical damage.
- Where it will be installed lower than four (4) feet from finished floor in areas where exposed to possible damage from area use activities.
- Where it will be subject to corrosive influence.
- Where it will be installed indoors in wet or damp locations.
- Where trade size is larger than 2".

Any of the above use conditions may be overridden by the Drawings.

Avoid use of dissimilar metals throughout system to reduce the possibility of galvanic action. Where dissimilar metals must be in contact, coat surfaces with corrosion inhibiting compound before assembling.

Use liquid-tight flexible metal conduit (LFMC) only where specifically indicated on the Drawings or where subjected to one or more of the following conditions:

- Flexible connection in an exterior location.
- Final 18" connection to motors.
- Equipment subject to movement or vibration.

Do not use PVC raceway unless such use is specifically indicated on the Drawings.

Use Flexible Metal Conduit (FMC) only for final connections to light fixtures and utilization equipment. Any other use shall be limited to applications where specifically indicated on the Drawings

Flexible Metal Conduit may not be used to interconnect device or junction boxes, utilization equipment, fixtures.

Flexible Metal Conduit length shall not exceed six feet.

Size raceway and raceway systems as follows:

Size raceway to meet NEC requirements, or as indicated on the Drawings, whichever size is larger, except no conduit smaller than 3/4 inch trade size shall be installed.

For underground use external to the building foundation no raceway smaller than 3/4 inch trade size shall be installed.

INSTALLATION OF RACEWAY SYSTEMS

General: Install raceways as indicated, in accordance with manufacturer's written installation instructions, and in compliance with the NEC and NECA's "Standards of Installation." Install raceway and related boxes and fittings plumb and level, ±2°. Maintain manufacturer's recommended clearances.

Fasten heavy wall conduit terminations in sheet metal enclosures by two locknuts, one inside and one outside of enclosure, and terminate with insulated bushing; terminate other conduit systems with connectors listed for the purpose and as described above.

Conduit couplers shall be steel threaded type in all locations where such use is possible. Otherwise use 3-piece union.

Conduit seals shall be steel threaded type in all locations. The drain shall be installed to allow automatic draining of condensation. Conduit seals shall be provided with a listed sealing compound.

Conduits are not to cross pipe shafts or ventilating duct openings. Conduit is not to be routed in elevator shafts unless necessary to serve items within the shaft.

Keep conduits a minimum distance of 6" from parallel runs of hot water pipes or other sources of heat. Wherever possible, install horizontal raceway runs above water piping.

Support riser conduit at each floor level with clamp hangers.

Use of running threads at conduit joints and terminations is prohibited. Where required, use threaded nipples and 3-piece unions.

Support exposed conduit by use of hangers, clamps or clips Listed for the purpose. Support conduit on each side of bends and on spacing not to exceed following:

- Rigid Metal Conduits Up to 1": 8'-0".
- Rigid Metal Conduits 1-1/4" and Over: 10'-0".
- EMT Up to 1": 8'-0".
- EMT 1-1/4" and Over: 10'-0".

Arrange conduit supports to prevent distortion of alignment by wire pulling operations. Fasten conduit using galvanized straps, lay-in adjustable hangers, clevis hangers, or bolted split stamped galvanized hangers Listed for the purpose. Requirements for exposed conduits also apply to conduits installed in space above hung ceilings.

Concealed Conduits:

- Metallic raceways installed underground, in floors below grade (where permitted), or outside are to have conduit threads painted with corrosion inhibiting compound before couplings are assembled. Draw up coupling and conduit sufficiently tight to ensure a water tight joint.
- For floors-on-grade (where permitted), install conduits under crushed rock and concrete slabs.
- Install underground conduits 24" below finished grade (24" cover) as a minimum or as otherwise indicated on the Drawings if a greater depth is shown.

Exposed Conduits:

- Install conduits in a manner so as not to damage or run through structural members. Avoid horizontal or cross runs in building partitions or side walls.
- Install exposed conduits and extensions from concealed conduit systems neatly, parallel with, or at right angles to walls of building.
- Install exposed conduit work as not to interfere with ceiling inserts, lights or ventilation ducts or outlets. Coordinate conduit installation with other trades as required.
- Install exposed conduit directly on structure using two hole straps. Provide offsets at all boxes and as required to avoid exiting utilities.
- Conduits installed on interior of exterior walls shall be spaced off the wall surface a minimum of ¼ inch with appropriate straps.

Run conduits for outlets on waterproof walls exposed where indicated on the Drawings. Set anchors for supporting conduit on waterproof wall in waterproof cement. Requirements for exposed conduit also apply to conduits installed in space above hung ceilings.

Raceway Fittings: Install connectors, couplers, and related fittings as required for a complete raceway system.

Install insulated bushings for terminating all types of raceway where termination is not made with an insulated throat connector.

Where concentric, eccentric or over-sized knockouts are encountered, a grounding-type insulated bushing shall be provided. Bushing shall be connected to the equipment grounding conductor.

Miscellaneous fittings such as reducers, chase nipples, 3-piece unions, and plugs are to be constructed from steel and specifically designed and Listed for their particular application.

Coordinate with other work including wires/cables, boxes, and panel work, as necessary to interface installation of electrical raceways and components with other work.

Mechanically fasten together metal conduits, enclosures, and other components comprising raceway system to form a continuous electrical conductor. Connect to electrical boxes, fittings and cabinets to provide electrical continuity and firm mechanical assembly.

Raceway must be installed as a complete system prior to the installation of cables, conductors, or pull wires into any part of the systems.

Install miscellaneous fittings such as reducers, chase nipples, 3-piece unions, and plugs that have been specifically designed and manufactured for their particular application. Install expansion fittings in raceways every 200' linear run maximum and wherever structural expansion joints are crossed.

Use roughing-in dimensions of electrically supplied utilization equipment furnished by supplier or by other divisions as appropriate. Set conduit and boxes for connection to units only after receiving review of dimensions and after verification of location with other trades.

> Do not set final connections for fixtures and/or utilization equipment until connection points and requirements are accurately known. The Contractor is responsible for the relocation of mis-located connection points as required to match equipment at no additional cost.

Cut conduits straight, properly ream. Threads shall be cut into heavy wall conduit using equipment designed for the purpose.

Make changes in direction of raceway run by means of proper field bends or with proper fittings, supplied by raceway manufacturer.

Field-bend conduit with benders designed for purpose so as not to distort nor vary internal diameter.

Properly support and anchor raceways for their entire length by structural materials. Raceways are not to span any space unsupported for lengths in excess of the maximum support distance as previously specified. Raceways may not be used to support other raceways or other items of equipment.

Arrange conduit to maintain headroom and present a neat appearance.

Route exposed conduit and conduit above accessible ceilings parallel and perpendicular to walls and adjacent piping.

Group raceway in parallel runs where three (3) or more raceway are routed together. Use conduit rack constructed of steel channel with conduit straps or clamps. Provide space for 25% additional conduit.

Do not fasten and/or hang conduit with wire or perforated pipe straps. Before conductors are pulled, remove all wire used during construction for temporary conduit support.

Bring conduit to the shoulder of fittings and couplings and fasten securely. All raceway shall be cut to proper length so ends fit accurately in connectors or couplers.

Use conduit hubs for fastening conduit to cast boxes and for fastening conduit to sheet metal boxes in damp or wet locations.

Use conduit bodies to make sharp changes in direction, as around beams.

Use hydraulic one-shot conduit bender for all field bends in conduit. All field made conduit bends shall meet minimum bending radius requirements of the NEC. Bends in metallic conduit shall be made while "cold". Factory made conduit sections may be used in lieu of field made bends for conduit larger than 2".

Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point.

Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture.

Where raceways penetrate walls or partitions separating spaces with differing environmental conditions, such as freezers, coolers and exterior walls, provide an internal seal to prevent condensation within the raceway as it enters the conditioned space.

Where conduit penetrates fire rated partitions, provide penetration protection in accordance with the UL through-penetration detail indicated on the Drawings for the type of partition and conduit involved. All instructions furnished with firestopping materials shall be followed explicitly.

Route conduit through roof openings for piping and ductwork where possible; otherwise, route through roof jack with pitch pocket. All pitch pockets shall be absolutely water tight; once conduit has been routed thought a pitch pocket the water integrity of the pitch pocket is the responsibility of the Division 26-28 Contractor.

Combining of circuits into raceway systems other than indicated on Drawings shall not be permitted.

Bolts, clamps, screws and expansion bolts shall be used in securing conduit, equipment, etc. Holes for lead shields or other anchors shall be the size recommended by the fastener manufacturer and shall be completely covered by the mounted item. Holes used for support of conduit on brick or block walls shall be located in mortar joints where such location is possible.

Provide nylon pull string in empty conduits where indicated, including conduit placed for telephone and data use. Conduit installed but left empty (with pull string) shall be tested with a ball mandrel. Clear any conduit that rejects ball mandrel. Any costs involved for restoration of conduit and surrounding surfaces to original condition are the responsibility of the Contractor.

Locate conduit EYS/EVS at each conduit entrance and exit to/from a hazardous classified area. Eys/Evs shall be located as close as practicable and, in no case, greater than 18 inches from the entry to each classified area.

END OF SECTION 260534

SECTION 260535 - ELECTRICAL BOXES AND FITTINGS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Manufacturers: Firms regularly engaged in manufacture of electrical boxes and fittings, of types, sizes, and capacities required, whose products are Listed and Labeled.

Codes and Standards:

NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wiring boxes and fittings.

Testing Laboratory Compliance: Comply with applicable requirements of UL 50, UL 514-Series, and UL 886 pertaining to electrical boxes and fittings. Provide electrical boxes and fittings that are Listed and Labeled.

SUBMITTALS

Submittals shall be made in strict accordance with the requirements of Section 019913. Specific submittal requirements are defined in each section of this Division.

Product Data: Submit manufacturer's data on electrical boxes and fittings.

PART 2 - PRODUCTS

FABRICATED MATERIALS

Aluminum products are not acceptable for use on the project.

Outlet Boxes: Provide galvanized coated flat rolled sheet-steel outlet wiring boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated, suitable for installation at respective locations. Construct outlet boxes with mounting holes, and with cable or conduit-size knockout openings in bottom and sides. Provide boxes with threaded screw holes for attachment of grounding conductor and cover plate or device attachment fittings.

Provide waterproof outlet boxes where box is installed in an outdoor location or in a wet location as defined by the NEC.

Outlet Box Accessories: Provide outlet box accessories as required for each installation, including box supports, mounting ears and brackets, wallboard hangers, box extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes. Supplied items shall be compatible with outlet boxes being used to fulfill installation requirements for individual wiring situations. Choice of accessories is Contractor's code-compliance option.

Device Boxes: Provide galvanized coated flat rolled sheet-steel device boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated, suitable for installation at respective locations. Unless otherwise specified device boxes shall be 4" square by 2 1/8” deep, flush mounted, and furnished with suitable plaster ring for the type devices to be used and of a depth to match the type of construction involved. Device boxes shall have ¾" knockout openings in bottom and ends, and with threaded screw holes in the rear for attachment of a grounding conductor. All fasteners shall have a corrosion resistant finish.

Where more than two devices are ganged together at a single location provide gangable device boxes with suitable partitions, conduit knockouts and attachment hardware.

Device Box Accessories: Provide device box accessories as required for each installation, including mounting brackets, device box extensions, switch box supports, plaster ears, and plaster board expandable grip fasteners, which are compatible with device boxes being utilized to fulfill installation requirements for individual wiring situations. Choice of accessories is Contractor's code-compliance option.

Where device boxes are surface mounted (as may permitted elsewhere) use cast steel type 'FS' boxes. Raintight device boxes shall have threaded conduit holes for the attachment of electrical conduit, cast-metal face plates with spring-hinged watertight caps suitable configured for each application, including face plate gaskets and corrosion-resistant plugs and fasteners. Boxes provided under this section shall have a threaded internal grounding conductor attachment point.

Device boxes exposed to outdoor or wet locations shall be flush mounted and shall be equipped with cast steel covers that are designed to exclude water when closed.

Provide covers that are suitable for use in wet location with device attached if such use is indicated on the Drawings.

Where flush mounting is not possible or not practicable due to the location of the device, provide surface mounted cast steel type 'FS' boxes as described elsewhere.

Junction boxes with no more than 4 entries of ¾" conduit containing conductors no larger than #12 may be 4" square by 2 1/8" deep with ¾" knockouts, threaded hole for connection of grounding conductor and threaded holes for the attachment of a blank cover plate. Provide suitable blank cover plate. Box extensions shall not be used to obtain more volume in 4" square junction boxes.

If box volume is not sufficient, the contractor may, as a code compliance option, may use 4 11/16" square by 2 1/8" deep boxes with ¾" knockouts, threaded hole for connection of grounding conductor and threaded hoses for the attachment of a blank cover plate. Provide suitable blank cover plate. Box extensions shall not be used to obtain more volume in 4 11/16" square junction boxes.

Use fabricated junction boxes as described below if box volumes that can be obtained by the use of 4" square or 4 11/16" square boxes are not sufficient to meet NEC minimum volume requirements.

Junction and Pull Boxes: Provide as required galvanized code-gage sheet steel junction and pull boxes, no knockouts, Listed, with screw-on covers. Types, shapes, and sizes of junction and pull boxes shall be suitable for each respective location and installation. Boxes shall have welded seams and shall be equipped with stainless fastening hardware. Provide steel barriers in boxes with multiple feeder circuits.

Auxiliary Wireways: Construct as required in accordance with UL 870, with Listed and Labeled components.

Construction: 16-gage galvanized sheet metal parts for 4" x 4" to 6" x 6" sections, and 14-gage parts for 8" x 8" and larger sections. Provide wireways with no knockouts.

Finish: Provide 14-gage and 16-gage galvanized sheet metal parts. Plate hardware to prevent corrosion.

In outdoor or wet locations provide wireways that are NEMA 3R. Do not use gaskets that can rip or tear during installation, or would otherwise compromise raintight capability of the wireway.

Do not use cover screws that will protrude into the trough area and damage wire insulation.

Size of device, outlet, junction, pull boxes, gutters, and similar components shall be as required to match the number of devices and/or conductors contained within as based on the requirements of NEC Article 314.16.

Bushings, Knockout Closures and Locknuts: Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit insulated bushings, offset connectors, of types and sizes, to suit respective installation requirements and applications.

Floor Boxes for Equipment Connection: Provide cast-iron raintight adjustable single gang floor boxes in locations as indicated. Boxes shall have threaded-conduit entrance ends, vertical adjusting rings, gaskets, and floor plates with raised screw-on covers suitable for minimum 3/4" conduit connection. Cover plate flange shall be suitable for the floor finish installed in locations as indicated. Cover plate, flange and screws shall be brushed aluminum finish.

Floor Boxes for Devices: Provide cast-iron raintight adjustable concealed service floor boxes suitable for concrete or wood floors in locations as indicated. Sheet metal floor boxes are not acceptable. Boxes shall be rectangular with appropriate partitions, threaded-conduit entrance ends, vertical adjusting rings, and gaskets. Cover plate flange shall be suitable for the floor finish installed in locations as indicated. Cover plate, flange and screws shall be brushed aluminum finish. Floor box shall accommodate quantity of power and telephone/data receptacles as indicated below and/or on the Drawings. Conduit connection sizes and quantities shall be coordinated with devices specified.

Floor Boxes for Electrical/IT Devices: Provide fire rated poke-thru adjustable floor boxes in locations as indicated. Boxes shall have threaded-conduit entrance ends, vertical adjusting rings and gaskets. Floor box shall accommodate quantity of power and telephone/data receptacles as indicated below and/or on the Drawings. Cover plate flange shall be suitable for the floor finish installed in locations as indicated. Cover plate, flange and screws shall be brushed aluminum finish.

Floor Boxes for Electrical/IT/AV Devices: Provide stamped sheet metal, fire classified, adjustable, concealed service floor boxes suitable for concrete floors in locations as indicated. Boxes shall be rectangular with appropriate partitions, threaded-conduit entrance ends, vertical adjusting rings, and gaskets. Cover plate flange shall be suitable for the floor finish installed in locations as indicated. Cover plate, flange and screws shall be brass finish. Floor box shall accommodate quantity of power, telephone/data and AV devices as indicated below and/or on the Drawings. Conduit connection sizes and quantities shall be coordinated with devices specified. Provide floor pan assembly for maintaining fire rating of floor assembly for larger boxes in elevated slabs.

Explosion Proof Junction Boxes: Boxes shall be rated flor Class 1, Division 2 locations. Cover shall be sealed with a gasket rated for exposure to gasoline vapors.

PART 3 - EXECUTION

INSTALLATION OF ELECTRICAL BOXES AND FITTINGS

General: Install electrical boxes and fittings as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices to fulfill project requirements.

Coordinate installation of electrical boxes and fittings with wire/cable, wiring devices, and raceway installation work.

Provide weatherproof boxes and fittings for interior and exterior locations that are exposed to weather or moisture. Weatherproof boxes must be Listed and Labeled and identified as "extra duty" for use in wet locations.

Provide knockout closures to cap unused knockout holes where blanks have been removed.

Install electrical boxes and similar items only in those locations that ensure accessibility to enclosed electrical wiring.

Avoid installing boxes back-to-back in walls. Provide not less than 6" separation in non-rated partitions. Provide 24" minimum horizontal separation in fire-rated partitions or in acoustic rated walls.

Position recessed outlet or device boxes in walls or ceilings accurately to allow for surface finish thickness. Where the surface material or covering is combustible the front edge of the plaster ring (or box) shall be flush (- 0",+1/32") with the finished surface. Where the wall or ceiling material is non-combustible, the front edge of the plaster ring (or box) may be recessed into the wall no further than 3/16". The maximum gap between the edge of an installed box/plaster ring combination shall not exceed 1/8". **These requirements will be rigidly enforced.**

Set floor boxes so that top edge of the box is level (± 5°) with finish flooring material. Install cover plates so that plate is flush (- 1/32",+ 0") with the finished floor level. **These requirements will be rigidly enforced**.

Do not use round boxes unless noted otherwise on the Drawings.

Fasten electrical boxes firmly and rigidly to substrates, or structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry. All boxes shall be supported independently of conduit.

Provide electrical connections for installed boxes.

Electrical box locations indicated on Drawings are approximate unless dimensioned. Verify location of outlets prior to rough-in. Coordinate exact locations with the work of other Divisions. Mis-located outlets and/or devices shall be relocated upon instruction from Owner's representative at no additional cost.

Locate and install to maintain headroom and to present a neat appearance.

Use multiple gang boxes where more than one device is mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems. Provide barriers to separate adjacent devices where the voltage is greater than 150 Volts between the devices.

Install boxes in walls without damaging wall insulation or fire proofing.

Position outlets to locate lighting fixtures and/or luminaries as indicated on Drawings. Boxes are to be positioned plum and vertical, $\pm$ 2°.

Align wall mounted outlet boxes for switches, thermostats, and similar devices.

Subsequent to installation of boxes, protect boxes from construction debris and damage.

GROUNDING

Upon completion of installation work, properly ground electrical boxes and demonstrate compliance with requirements.

END OF SECTION 260535

SECTION 260593 - ELECTRICAL CONNECTIONS FOR EQUIPMENT

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Manufacturers: Firms regularly engaged in manufacture of electrical connectors and terminals, of types and ratings required, and ancillary connection materials, including electrical insulating tape, solder/fluxes, and cable ties, whose products are Listed.

Codes and Standards:

NEC Compliance: Comply with applicable requirements of NEC as to type products used and installation of electrical power connections (terminals and splices), for junction boxes, motor starters, and disconnect switches.

Testing Laboratory Compliance: Comply with UL Std. 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors" including, but not limited to, tightening of electrical connectors to torque values indicated. Provide electrical connection products and materials that are Listed and Labeled.

SUBMITTALS

Submittals shall be made in strict accordance with the requirements of Section 019913. Specific submittal requirements are defined in each section of this Division.

Product Data: Submit manufacturer's data on electrical connections for equipment products and materials.

PART 2 - PRODUCTS

MATERIALS AND COMPONENTS

General: For each electrical connection indicated, provide complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, cable ties, solderless wire-nuts, and other items and accessories as needed to complete splices and terminations of types indicated.

Metal Conduit, Tubing and Fittings:

General: Provide metal conduit, tubing and fittings of types, grades, and sizes indicated for each type service. Where types and grades are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements and comply with NEC requirements for raceways. Provide products complying with Section 260534, *RACEWAYS*, and in accordance with the following listing of metal conduit, tubing and fittings:

Rigid steel conduit

Rigid metal conduit fittings

Electrical metallic tubing

EMT fittings

Flexible metal conduit

Flexible metal conduit fittings

Liquid-tight flexible metal conduit

Liquid-tight flexible metal conduit fittings

Wires, Cables, and Connectors:

General: Provide wires, cables, and connectors complying with Section 260519, *SECONDARY VOLTAGE WIRES AND CABLES*.

Wires/Cables: Unless otherwise indicated, provide conductors for electrical connections that match, including sizes and ratings, of wires/cables that are supplying electrical power. Provide copper conductors with conductivity of not less than 98% at 68° F.

Connectors and Terminals: Provide copper electrical connectors and terminals that mate and match, including sizes and ratings, with equipment terminals and are recommended by equipment manufacturer for intended applications. **Aluminum conducting components are not acceptable for use on this project.**

Electrical Connection Accessories: Provide electrical insulating tape, wirenuts and cable ties as recommended for use by accessories manufacturers for type services indicated.

PART 3 - EXECUTION

INSPECTION

Inspect area and conditions under which electrical connections for equipment are to be installed and notify A-E in writing of conditions detrimental to proper completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

INSTALLATION OF ELECTRICAL CONNECTIONS

Install electrical connections as indicated in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC and NECA'S "Standard of Installation" to ensure that products fulfill requirements.

Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.

Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.

Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating than electrical insulation rating of those conductors being spliced.

Prepare cables and wires by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes that will remain on conductors. Also avoid "ringing" copper conductors while skinning wire.

Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance. Leave a minimum of 6” of excess spare conductor at each termination.

Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers published torque tightening values for equipment connectors. Accomplish tightening by utilizing proper torquing tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Where manufacturer's torque requirements are not available, tighten connectors and terminals to comply with torque values contained in UL 486A.

Provide flexible connections to equipment as follows:

Provide Flexible Metal Conduit (FMC) for connection of electrical equipment where subject to movement and vibration or as otherwise required by the Specifications or on the Drawings.

Provide metal Liquidtight Flexible Metal Conduit (LFMC) for equipment in exterior locations, wet locations, or in other locations where so indicated on the Drawings.

Fasten identification markers to each electrical power supply wire/cable conductor that indicates their voltage, phase and feeder number in accordance with Section 260533, *ELECTRICAL IDENTIFICATION*. Affix markers on each terminal conductor, as close as possible to the point of connection.

FIELD QUALITY CONTROL

Upon completion of installation of electrical connections, and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor fulfills requirement. Correct malfunctioning units at site, then retest to demonstrate compliance.

END OF SECTION 260593

SECTION 260596 – LIGHTING SYSTEMS COMMISSIONING

PART 1 – GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

GENERAL

Lighting systems commissioning shall be performed by the Contractor and shall include the following:

Establish a verification “team” consisting of the installing personnel and the controls subcontractor.

Systematically evaluate all installed lighting control systems and components to ensure that control hardware and software are calibrated, adjusted, programmed and in proper working condition in accordance with the construction documents and manufacturer’s instructions

Perform verification procedures, equipment functional performance tests, and tests of the sequences of operations to verify that the controls are providing the correct interaction between equipment and controls systems.

PART 2 – DESIGN INTENT

GENERAL

The contract documents define the requirements for lighting control systems and components, along with the control requirements for each element. It is the intent of the Designer that all lighting control systems and components shall perform in accordance with the criteria defined in Sections 260923 and 260924.

PART 3 – FUNCTIONAL PERFORMANCE

SYSTEMS START-UP

Contractor shall organize the requirements outlined in this section with that of the manufacturer’s and/or applicable codes and standards to develop specific and itemized start up procedures specific to that installed on this project.

OCCUPANT SENSOR CONTROLS

Where occupant sensor controls are provided, perform the following procedures for each installed sensor:

1. Verify that the occupant sensor has been located and aimed in accordance with manufacturer recommendations.

2. Verify that the occupancy sensor functions have been correctly set up in accordance with the requirements of Section 260923.

3. Verify correct operation of status indicators.

4. Verify controlled lights turn off or down to the permitted level within the required time.

5. Verify occupancy sensors turn lights on to the permitted level when an occupant enters the space.

6. Verify vacancy sensors require manual activation of lights.

7. Verify lights are not turned on by movement in adjacent spaces or by HVAC operation.

PHOTOCONTROL SWITCHES

Where photocontrol switches are provided, perform the following procedures for each installed switch:

1. Verify that switch correctly turns lights on/off in response to external lighting conditions.

2. Verify that switch is not adversely impacted by artificial lighting.

Where photocontrol switches are arranged to directly control area lighting, perform the following procedures for each switch:

1. Verify that the override limit is set to 2 hours.

2. Verify that switch controls all intended lighting.

RELAY PANELS

Where relay panels are provided, perform the following procedures for each installed panel:

1. Verify that each relay controls lighting specified on drawings.

2. Verify the correct time and date are established in the relay panel.

3. Verify that battery backup is installed, energized and operational.

4. Verify that time controlled and photocontrol switch inputs are properly mapped to intended relays.

5. Verify that the override stations are arranged to control intended lighting as shown on the drawings. Verify the override limit is set to 2 hours.

6. Verify that master station controls all intended zones of building.

7. Verify that all nonexempt lighting turns on/off in response to set times in time switch.

FUNCTIONAL PERFORMANCE TESTS AND CERTIFICATION

Functional performance tests shall be performed in accordance with the checklists in this section to prove all modes of the sequences of operation and to verify all other relevant contract requirements. Tests shall begin with equipment or components and shall progress to complete systems. Upon failure of any functional performance test checklist item, the Contractor shall correct all deficiencies in accordance with the applicable contract requirements. **The checklist shall then be repeated until it has been completed with no errors.**

Functional performance tests shall begin only after all work and testing required in related specification sections have been successfully completed and the lighting control systems are fully functional, after all test and inspection reports and operation and maintenance manuals required have been submitted and reviewed by the A/E.

The verification team shall utilize standardized reporting forms included in project manual for each item described in this section to document the required functional performance tests. Each test shall be certified with the following statement and the signature and date of signing by each member of the verification team:

"We the undersigned have performed the functional performance tests described herein and certify that the item tested has met the performance requirements of Sections 260923 and 260924.

Signature and Date:

Electrical Contractor's Representative _____

Lighting Controls Sub-Contactor Representative _____"

END OF SECTION 260596

SECTION 260800 - TESTING AND PLACING IN SERVICE

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of contract, including general and supplementary conditions and Division-1 Specification Sections, apply to work of this Section.

WORK INCLUDED

Provide all material, equipment, labor and technical supervision to perform and complete the electrical acceptance tests in accordance with the requirements of this section for equipment installed as the Work of this contract. Notify A-E at least four (4) working days in advance of tests.

Perform Tests on the Following Equipment and/or in the following areas:

- Cable Tests
  - Low Voltage (≤ 600 Volt)
  - High Voltage (> 600 Volt)
- Grounding
- Ground fault operation and coordination
- Overcurrent devices
- Service Equipment Tests
- Switchboards and Panelboards (≤ 600 Volt)
- Switchgear (> 600 Volt)

DEFINITIONS

Measure: To obtain the requested system information by use of suitable instruments and to record this information in the appropriate section of the test report.

Repaired: Material or equipment that has been brought to new condition, retested and made to pass all required tests.

QUALITY ASSURANCE

Perform tests to obtain required information in accordance with accepted industry procedures and/or in accordance with manufacturer's recommendations. Should manufacturer's recommendations conflict with these specifications, notify A-E. Do not proceed with tests until directed by A-E.

Material or equipment failing tests shall be repaired or replaced at the Contractor's expense.

The Contractor shall be responsible for all tests and for documentation of test data. Testing shall be performed by or under the immediate supervision of the Contractor.

DOCUMENTATION

Records of all tests and inspections, with complete data on all readings taken, shall be made and incorporated into a single report.

Five (5) bound copies of all test reports shall be submitted at the end of the test period. All required documentation of readings indicated above shall be submitted to the engineer prior to, and as one of the prerequisites for, final acceptance of the project.

PART 2 - PRODUCTS

The Contractor shall employ testing devices as required to accomplish specified testing herein and as described elsewhere in the Contract Documents.

Test Equipment Suitability: The test equipment used by the Contractor shall be suitable for the intended tests and shall comply with ANSI/NETA ATS-2009, Section 5.2.

Test Equipment Calibration: The test equipment used by the Contractor shall be suitable for the intended tests and shall comply with ANSI/NETA ATS-2009, Section 5.3.

PART 3 - EXECUTION

GENERAL

Check cable continuity and phase identification for each conductor used on the project. This includes service conductors, feeders, and branch circuit conductors. It is not required to document this test in the testing report required under this section.

Insulation testing: The insulation tests (megger tests) as specified in this Section are the minimum readings desired at an ambient temperature of 60° F and a low relative humidity.

Megger readings taken at other than ambient temperature of 60° F shall be corrected to 60° F.

When megger readings fall below the specified minimum values utilize recognized means to dry out the equipment. The method utilized by the Contractor must be in accordance with manufacturer's written instructions.

If drying is to be accomplished by applying an electric potential to a cable or piece of equipment, then, in no case (induced or direct) shall the voltage or current exceed the ampacity or the continuous rating of the equipment being dried.

CABLE TESTS

General: Disconnect each end of all cables from their associated equipment prior to the test.

Cables ≤ 600 Volt: Inspect all cable connections for workmanship and conformance with standard practice.

Perform the following tests:

Test cable insulation using a megger.

Perform megger tests between phases and between each conductor and ground with the other conductors and interlocked armor (if part of cable assembly) grounded.

Test other conductors in the same manner. The minimum acceptable megger reading for cables shall be 1 megohm (MΩ) for #6 AWG conductors and smaller and 250,000 ohms (Ω) for #4 AWG conductors and larger.

The Test Record Shall Include the Following:

Complete identification of the cable, including approximate length.

Megger reading data.

Cables > 600 Volt: Test cables only after all terminations and splices are complete.

Test all three-conductor/single-conductor cables between phases and between each conductor and ground with the other two conductors, shields, and the interlocked armor (if part of cable assembly) also grounded to the same ground.

Perform a dielectric absorption test with a megger on the cable. Record the readings obtained by this test in the test record.

Apply the dielectric absorption megger test for sufficient duration to fully charge the cable.

Take megger readings every fifteen seconds during the first three (3) minutes and at one (1) minute intervals thereafter.

Continue the test until three (3) equal readings one (1) minute apart are obtained.

The cable may then be considered to be fully charged.

Perform a high potential test. The high potential test shall be applied for five (5) minutes.

Apply the test voltage gradually during the first minute with initial application being not greater than the rated voltage of the cable.

The leakage current readings at 30 second intervals during the first two (2) minutes of the test and one (1) minute intervals during the remainder of the test.

If the leakage current is increasing at a rate that indicates impending cable failure, stop the test. The cable shall withstand the specified high voltage without breakdown.

Should impending failure be indicated or failure occur, state in report, the cause of first test failure and remedy.
After the high potential test, repeat the dielectric absorption test.

The results of the final absorption test shall be reasonably parallel with those of the initial test and shall show no evidence of permanent injury to the cable caused by the high potential test.

The Test Record Shall Include the Following:

- Complete identification of the cable, including approximate length.
- Megger readings versus time data.
- High potential versus time data.
- Leakage current versus time data.
- The approximate average cable temperature.

GROUNDING

Resistance: Measure the resistance (relative to earth) of each electrical equipment ground brought up from each grounding electrode, made electrode (rod), and the underground grid.

Do not measure outside ground rod and ground grid resistances to earth during unusually wet weather.

The Test Record Shall Include the Following:

Identification of the ground point where the test is performed.

Value of resistances relative to earth.

Test ground resistance with tester equivalent to Fluke 1625. Test arrangement shall be based on a three point, fall of potential test. Two field installed stakes used for the test shall be placed to form a line with the driven grounding electrode and separated at intervals of 60 feet. Where tests show resistance-to-ground is over 25 Ohms, take appropriate action to reduce resistance to 25 Ohms, or less, by driving additional ground rods; then retest to demonstrate compliance.

GROUND FAULT OPERATION AND COORDINATION

Upon selection of the product line and approval of the equipment submittal package, the engineer shall conduct a coordination study to determine appropriate settings for adjustable circuit breakers. The ground fault protection on the circuit breakers shall be set in accordance with information provided by the engineer.

Performance Testing of Time-Current Functions: For services 1,000 amperes and larger, the following tests should be performed on the service circuit breakers and the distribution circuit breakers. Using circuit breaker test set, set and field test time-current trip functions for new circuit breakers to verify operation in accordance with the circuit breaker settings provided by the engineer. Testing shall be performed by a qualified factory technician at the job site. All readings shall be tabulated:

Ground fault tripping tolerance (within 20% of UL requirements).

Trip time in seconds.

Where additional testing of existing equipment is indicated on the drawings, use circuit breaker test set to set and field test time-current trip functions for existing circuit breakers to verify operation in accordance with the circuit breaker settings provided by the engineer.

OVERCURRENT DEVICES

Upon selection of the product line and approval of the equipment submittal package, the engineer shall conduct a coordination study to determine appropriate settings for adjustable circuit breakers. The time-current protection on adjustable circuit breakers shall be set in accordance with information provided by the engineer.

Performance Testing of Time-Current Functions: For services 1,000 amperes and larger, the following tests should be performed on the service circuit breakers and the distribution circuit breakers. Using circuit breaker test set, set and field test time-current trip functions for new circuit breakers to verify operation in accordance with the circuit breaker settings provided by the engineer. Testing shall be performed by a qualified factory technician at the job site. All readings shall be tabulated:

Phase tripping tolerance (within 20% of UL requirements).

Trip time (per phase) in seconds.

Instantaneous trip (amps) per phase.

Insulation resistance (in megohms) at 1,000 volts (phase to phase, and line to load).

Where additional testing of existing equipment is indicated on the drawings, use circuit breaker test set to set and field test time-current trip functions for existing circuit breakers to verify operation in accordance with the circuit breaker settings provided by the engineer.

Operational Test Procedures for Circuit Breakers: Visually inspect and manually operate breakers through a minimum of three (3) open/close cycles. Check for correct alignment, freedom from binding and good contact. Check phase matching and phase rotation immediately prior to energizing of equipment.

SERVICE EQUIPMENT TESTS

Voltage Tests: Measure the no-load and full-load voltages (phase-to-phase and phase-to-ground for each phase) of each service and for each separately derived system.

Load Tests: Measure the load on each phase of the main service and each phase of every feeder under maximum load conditions.

The Test Record Shall Include the Following:

Complete identification of each test location.

Values of no-load and full-load voltage.

Values of no-load and full-load current.

SWITCHBOARDS AND PANELBOARDS (≤ 600 VOLT)

Prior to testing, inspect all compartments and apparatus.

With all breakers, fused switches, starters, and contactors in the open position and cables connected, test the bus insulation for each phase with a megger. The minimum acceptable megger reading shall be 100 megohms (MΩ).

Manually and automatically, as applicable, operate all breakers, switches, contactors, relays, motor starters and the like to ascertain that correct and positive operation, interlocking and alarm have been achieved.

After all fixtures, devices and equipment are installed and all connections completed to each panel, the Contractor shall disconnect the neutral feeder conductor from the neutral bar and take a megger reading between the neutral bar and the grounded enclosure. If this reading is less than 250,000 Ohms, the Contractor shall disconnect and test each branch circuit neutral wire to the grounded enclosure to isolate the low readings. The Contractor shall correct troubles, reconnect and retest until a minimum resistance of 250,000 Ohms exists between the neutral bar and ground with only the feeder neutral disconnected.

The Test Record Shall Include the Following:

Complete identification of panelboard.

Resistance of each phase bus relative to ground

Resistance between neutral bus and ground bus with neutral lifted.

SWITCHGEAR (> 600 VOLT)

Visual Inspections: Check transformer tap settings for correctness in accordance with approved drawings. Check continuity, polarity and correctness of connections of all windings.

Inspect all power cable connections for workmanship connection.

Check all cubicle ground connections.

Overcurrent Device Operational Tests: Operate each device through three (3) open-close-open cycles. Operate drawout devices in both the rack-in and test positions. Check mechanisms for correct alignment, freedom from binding and good contact.

Check drawout devices for ease of rack-in and rack-out.

Check drawout devices to determine that they cannot be rolled out of or into operating position with the main contacts closed.

Operate remotely controlled devices once from each control point, observing all indicating lights, annunciators, alarms and targets for correct operation.

Insulation Tests: Perform a megger test on each transformer primary, each transformer secondary, and each switchgear bus.

Perform the tests with all current transformer secondaries shorted and grounded and all potential transformer primary fuses removed and the housing grounded.

Apply megger tests on each transformer winding between all phases tied together and ground. Ground all windings and adjacent cables or breaker contacts not included in the test.

Apply megger tests on busways between each phase and ground with the other phases grounded. Ground all adjacent cables and breaker contacts not included in the test.

Apply megger tests on breakers between each phase and ground with the other phases grounded and breaker in the racked-out position.

Specified Megger and High Potential Tests Shall Be As Follows:

EQUIPMENT	MEGGER VOLTAGE	MIN. MEGGER READING (megohms)
4160 Volt bus	2500	800
480 Volt bus	500	10
480 Volt breaker	500	100
208 Volt breaker	500	100
Current Transformer secondary wiring	500	5

In accordance with manufacturer's recommendations, maintain 2500-Volt and 500-Volt megger tests until the reading reaches a constant value and until three (3) consecutive equal readings one (1) minute apart are obtained. Maintain all 2500-Volt megger tests at least five (5) minutes and until three (3) consecutive readings one (1) minutes apart are obtained. Take readings every 30 seconds during the first two (2) minutes and every minute thereafter. Record all megger readings.

Acceptance: Make complete and accurate records of all tests. All megger readings shall pass manufacturer's specified and minimum values. Equipment shall pass operational tests and visual inspection requirements.

The Test Record Shall Include the Following:

Complete identification of all test points, including a description of which terminals are shorted and/or grounded.

Megger readings versus time data.

The approximate average equipment temperature.

END OF SECTION 260800

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 – GENERAL

RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

SUMMARY

This Section includes time control switches, daylight sensors, occupancy sensors, and multi-pole lighting relays and contactors.

QUALITY ASSURANCE

Manufacturers: Firms regularly engaged in manufacture of lighting control devices, of types and ratings required in this Section, whose products are Listed and Labeled for the purpose intended. Subject to compliance with requirements provide equipment equivalent to that provided by manufacturers listed in this Section.

Codes and Standards:

NEC Compliance: Comply with NEC requirements pertaining to lighting control devices.

Code of Federal Regulations Compliance: Comply with 47 CFR 15, Subparts A and B, for Class A digital devices.

SUBMITTALS

Submittals shall be made in strict accordance with the requirements of Section 019913. Specific submittal requirements are defined in each section of this Division.

Product Data: Include dimensions and data on features, components, and ratings for lighting control devices.

Samples: Provide samples of submitted occupancy sensors for color selection and evaluation of technical features if requested in writing by the A-E. If approved, the sample may be used on the project.

Shop Drawings: Submit shop drawings showing equipment, with proposed quantities and locations, and connecting wiring of lighting controls system. Layout and wiring diagrams shall be based on the project floor plans, with devices and proposed control groups shown. Provide clearly drawn connections between control devices and controlled lighting in all rooms and/or areas where multiple control groups are present. Provide distinctive boundaries for override zones on each floor unless specified as a single zone for floor. Provide equipment designations that will coincide with documentation of Functional Performance Tests outlined in Section 260596. Provide a draft of the narrative of system operation specified in this section as part of the Operations and Maintenance Manual.

Provide coverage pattern templates for each occupancy sensor type used as part of the project. Where requested by the Engineer, provide drawings that overlay the proposed coverage patterns on the project lighting plans. Provide summary of settings available for each sensor type. Identify and highlight deviations from options/setting specified in this Section.

Provide summary of settings available for each time clock.

Maintenance Data: For lighting control devices to include in maintenance manuals specified in Division 1.

PART 2 – PRODUCTS

OCCUPANCY SENSORS

Manufacturers: Provide equipment equivalent to that provided one of the following manufacturers:

- Wattstopper
- Novitas
- Sensor Switch
- Hubbell

Sensors shall be provided with a single pole, isolated relay (30V AC/DC, 1A) for interface with building automation system. Relay and contact ratings shall be clearly indicated in submittal literature.

Occupancy sensors are diagrammatically indicated on the lighting plans, based on coverage areas of approximately 1,000 square feet/sensor for ceiling heights up to 10 feet. Contractor shall verify the locations and quantities of sensors installed to properly cover each space based on actual coverage patterns of submitted/approved products. Sensors shall be installed in coordination with the manufacturer's instructions, including separation from air distribution patterns associated with HVAC diffusers.

Wall Switch Occupancy Sensor: Provide a wall mounted, dual technology occupancy sensor with a manual on/off switch. Switch shall support manual-on and automatic-on (previous setting) operation. Switch to be rated at 800W @ 120V and 1,200W @ 277V. Provide vandal resistant, hard usage lens for sensor.

Wall Switch Occupancy Sensor/Dimmer: Provide a wall mounted, dual technology occupancy sensor with 0-10V dimming. Switch shall support manual-on and automatic-on (previous setting) operation. Multiple switches may be used together, each providing full dimming operation, in up to four locations for a switch group. Switch to be rated at 1,000W @ 120V and 1,200W @ 277V. Provide vandal resistant, hard usage lens for sensor.

Dual Technology Ceiling Mounted Occupancy Sensor: Provide a 24 VAC ceiling mounted combination passive infrared and ultrasonic sensor. Coverage for normal desktop motion shall be 900 square feet at a 360° pattern. Provide sensor with an integral daylighting control interface. Provide compatible power modules as required to interconnect sensors to controlled loads.

Sensors shall be provided with the following options and set in accordance with values listed.

Sensor Parameter	Option	Setting
Activation	Manual / Automatic	Automatic
Time Delay		15 minutes
Walk Through	On / Off	Off
PIR Sensitivity	10-100% (10% increments) / Off	90%
Ultrasonic Sensitivity	10-100% (10% increments) / Off	70%
Test Mode	In / Off	Off
Detection Technology	Ultrasonic / PIR / Both / Either	Both
Retrigger Technology	Ultrasonic / PIR / Both / Either	Either

LOW VOLTAGE ROOM CONTROL PACKAGES

Where indicated on the drawings, provide integrated low voltage room control platforms equivalent to that provided one of the manufacturers listed above. Control package shall utilize Cat 5E (minimum) connections from room controller to ancillary control devices (manual switch/dimming, occupancy sensors, daylight sensors) indicated for the application. Connection to sensors shall be accommodated by RJ45 adaptors included with the room control package. Where specified as part of the control scheme, fixture dimming shall be smooth across 0-10V range in response to daylight sensors.

TIME CLOCKS

Electronic Time Clock: Provide a 365-day, 2 circuit astronomic programmable controller. Controller to include following functions and options:

- 4 On's and Off's per day.
- Skip a day capability.
- Four seasonal schedules.
- Daylight Savings and Leap year adjustment.
- Up to 40 assignable holiday blocks.
- Battery backup 72 hour minimum.
- Integral Digital Display.

Time clocks shall be provided with the following options and set in accordance with values listed. Contractor shall request in written form all Owner Defined settings and provide written response as part of documentation of testing and commissioning.

Control Parameter	Option	Setting
Daylight Savings Time	Override or Automatic	Automatic
Leap Year Adjustment	Override or Automatic	Automatic
Sunrise Offset		30 minutes after
Sunset Offset		30 minutes before
Holidays	0-40 minimum	Owner Defined
On		Owner Defined
Off		Owner Defined

CONTACTORS

General: Except as otherwise indicated, provide contactors and ancillary components that comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation.

Lighting Contactors: Provide full voltage alternating current lighting contactor, of types, sizes, ratings, and NEMA sizes indicated. Equip contactors with mechanically held contacts. Construct and mount starters in NEMA Type 1 enclosure; coat with manufacturer's standard color finish.

OVERRIDE SWITCHES

General: Provide override switches as indicated on the Drawings. Switches shall be located to provide for the override specific lighting during unoccupied hours. Switch type and arrangements shall be compatible with the automatic control device (time clock, contactor) used for lighting. Lights shall be energized in response to override switches for 2 hours.

PUSHBUTTONS

General: Except as otherwise indicated, provide pushbuttons and ancillary components that comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation.

Selector Switches: Provide selector switches (H-O-A) with red pilot light as indicated, flush mounted, heavy duty, oil-tight, maintained contact, indicating lights. Selector switches shall be mounted in flush wall mounted enclosures.

Provide galvanized sheet steel cabinet type enclosures, flush wall mounted, in sizes and NEMA 1 as indicated, code gauge, minimum 16 gauge thickness. Construct without knockouts. Provide fronts with adjustable trim clamps, and with concealed piano door hinges and door swings as indicated. Provide metal pushbutton mounting within enclosure, 14 gauge thickness. Equip with interior directory frame, and card with clear plastic covering. Provide baked gray enamel finish over a rust inhibitor coating. Provide enclosures that are fabricated by same manufacturer as panelboards.

TIME CONTROL SWITCHES

Provide electrically operated time control switches with 24-hour dials capable of periodically and automatically switching indoor and outdoor lamps both ON and OFF. Select switches that permit selection of from 1 to 12 ON-OFF operations each day and allows timing durations of 1 to 23 hours, with ratings of 125 Volts, 60 Hz, and with SPST switch of 10-amperes per pole. Provide enclosure with side hinged door and lock, mounting holes and knockouts, of 0.036" drawn steel. Provide timing switch with manual circuit by-pass switch and separate grounding terminal. Finish enclosure with manufacturer's standard gray finish.

Spring Wound Timer: Provide spring wound 0-1 hour twist timer, rated for 10 Amps, 120-277 Volts.

PHOTOCONTROL SWITCHES

Photocontrol Switches: Provide electrically operated photocontrol switches, rated 1,800 Watts, 120 Volts, 60 Hz, weatherproof enclosure, external pipe threaded nipple, fail safe, load to remain ON in case of cell failure.

RELAY CONTROL SWITCHES

Provide branch circuit relay control switches suitable for use with auxiliary generator or inverter system to control branch circuit lighting loads up to 20A regardless of local switch position. The device consists of relay switching circuitry in a single, wall mounted enclosure. The relay control switch includes integral sensing circuitry that senses loss of power of an identified circuit. Once power loss is sensed it automatically switches to the emergency source. Unit shall be suitable for any type of light source at both 120V and 277V.

Unit shall meet applicable requirements of UL 1008, Standard for Safety Transfer Switch Equipment and applicable NEC requirements.

Provide relay control switch in 9”W x 6”H x 3.5” D steel enclosure, UL listed for use in damp location. Provide enclosure with LED indicators that identify switch position.

Provide relay control switch with 45mA, 4 watt sensing circuit to monitor normal source. Provide auxiliary relay contacts as required to bypass dimming controls when used to control circuits served through a dimming system.

LIGHTING INVERTERS

Single Circuit Inverter: Provide stackable/modular single circuit inverter with 1,500 VA capacity. Unit shall be suitable to provide 90 minutes of back up battery power for the full rating of the unit. Inverter shall be suitable for LED and fluorescent, dimming and non-dimming loads at 120V/277V single phase.

Manufacturers: Provide equipment equivalent to that provided one of the following manufacturers:

- Myers Power Products Illuminator IE Series
- Dual-Lite Synchron Series
- Beghelli Nova UAC-P Series

Unit shall have a 16 gauge steel enclosure and powder coated painted surface. Unit shall have sealed lead calcium maintenance free batteries.

Unit shall be NFPA, OSHA, NEC compliant and shall be UL 924 listed.

Unit shall have circuit breaker trip alarm, self testing, diagnostics and integral event alarm and test logs, RS 232 interface, LCD display. Unit shall include battery, input and output circuit breakers and an integral alarm dry contact.

PART 3 – EXECUTION

INSTALLATION

Install equipment level and plumb and according to manufacturer's written instructions.

Mount lighting control devices according to manufacturer's written instructions and requirements in Section 260500, *BASIC ELECTRICAL REQUIREMENTS*.

Mounting heights indicated are to bottom of unit for suspended devices and to center of unit for wall-mounting devices.

Spare Parts: Provide the following spare parts with the system, each individually packaged and labeled. For multi-building projects, calculate separately for each building:

Wall mounted occupancy sensors (each type)	4% of installed quantity
Ceiling mounted occupancy sensors (each type)	4% of installed quantity

Increase decimal quantities of spare parts to the next higher whole number. For example if a system has 20 wall mounted passive infrared sensors, provide 2 spare sensors.

CONTROL WIRING INSTALLATION

General: Install wiring between sensing and control devices according to manufacturer's written instructions and as specified in Section 260519, *SECONDARY VOLTAGE WIRES AND CABLES*, for low-voltage connections and for digital circuits.

Wiring Method: Install all wiring in raceway as specified in Section 260534, *RACEWAYS* and Section 260535, *ELECTRICAL BOXES AND FITTINGS*.

Connections: Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

IDENTIFICATION

Identify components and power and control wiring according to Section 260533, *ELECTRICAL IDENTIFICATION*.

FIELD QUALITY CONTROL

Inspect control components for defects and physical damage, testing laboratory labeling, and nameplate compliance with the Contract Documents.

Verify settings of photoelectric devices with photometer calibrated within previous six months.

Electrical Tests: Use particular caution when testing devices containing solid-state components. Perform continuity tests of circuits prior to installing devices. Perform operational tests according to manufacturer's written instructions. Set and operate devices to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions. Test devices under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.
Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

CLEANING

Cleaning: Clean equipment and devices internally and externally using methods and materials recommended by manufacturers, and repair damaged finishes.

TESTING & DOCUMENTATION

Provide a minimum 90 minute battery test for each inverter under complete load. Provide documentation of output voltage at unit at beginning of the test and at the end of the 90 minute period. All product features shall be verified by the Contractor and demonstrated for the engineer.

Provide verification of proper installation of components and systems as outlined in Section 260596, Lighting Systems Commissioning. Provide all necessary components to properly demonstrate operation of equipment to engineer.

OPERATIONS AND MAINTENANCE MANUAL

Manuals shall include product data for all installed products that identifies all selected options for each component of lighting controls system.

Identify manufacturer's requirements and recommendations for routine maintenance actions, recalibration and cleaning. Identify schedule for items above.

Provide a narrative of the system operation, specific to the installation, including the actual set points.

TRAINING

Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:

Train Owner's maintenance personnel on troubleshooting, servicing, adjusting, and preventive maintenance. Provide a minimum of 16 hours of training.

Training Aid: Use the approved final version of maintenance manuals as a training aid.

Schedule training with Owner, through A-E, with at least seven days' advance notice.

WARRANTY PERIOD

Warranty period for occupancy sensors shall be one year, beginning upon acceptance of the installation by the Owner. Include up to three site visits within the first year, upon request by the Owner, to adjust light levels, make program changes, and adjust sensors and controls to suit actual conditions.

Warranty period for branch circuit inverters shall be full 3 years for defects in workmanship, battery and materials. Battery shall have an additional 7 year prorated warranty.

END OF SECTION 260923

SECTION 260924 - LIGHTING RELAY PANEL

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of contract, including general and supplementary conditions and Division-1 Specification Sections, apply to work of this Section.

QUALITY ASSURANCE

Manufacturers: Firms regularly engaged in manufacture of electrical products, of types and ratings required in this Section, whose products are Listed and Labeled for the purpose intended. Subject to compliance with requirements provide devices equivalent to one of the following manufacturers:

ILC
Lutron
Wattstopper

Codes and Standards:

Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction of NEC as applicable to construction, installation of lighting control and communications equipment.

Testing Laboratory Compliance: Comply with applicable requirements of UL Std. 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors." Provide lighting control equipment and components that are Listed and Labeled.

NEMA Compliance: Comply with applicable portions of NEMA standards pertaining to types of electrical equipment and enclosures.

UL Approvals: Remote panels are to be UL listed under UL 916 Energy Management Equipment.

FCC Emissions: All assemblies are to be in compliance with FCC emissions Standards specified in Part 15 Subpart J for Class A application.

SUBMITTALS

Submittals shall be made in strict accordance with the requirements of Section 019913. Specific submittal requirements are defined in each section of this Division.

Shop Drawings: Submit dimension drawings of all lighting control system components and accessories.

Product Data: Submit manufacturer's data on lighting control equipment and components.

Block Diagram: Submit a block diagram of the system showing all components and all connections, the block diagram shall clearly indicate all items that are supplied under other sections of these specifications. Indicate all interconnections and power sources for all items shown on diagram.

PART 2 - PRODUCTS

Relay panels shall be mounted in electrical closets as indicated on the drawings. The numbered relays in the panel shall be wired to control the power to each load as indicated on the Panel Schedules included in the drawings. All power wiring will be identified with the circuit number controlling it at the load.

Relay panels shall provide a mounting bracket for the addition of group relay controllers and time clocks, as required for the location. These control devices shall be totally compatible with the manual operation of the low voltage switches.

Modular relay panels shall be UL listed and consist of the following:

Tub: Empty NEMA 1 enclosure sized to accept an interior with 48 relays.

Interior: Bracket and circuit board backplane. Interiors shall be sized to accept 24 relays.

Relays: Lighting control relays shall be suitable for all types of loads up to 20 Amperes. Load contacts shall withstand 1500 amps of fault current for up to 20 mS. Relays shall be momentary-pulsed mechanically latching contactors rated at 20 amps, 120-277 VAC. Relays shall attach to the panel interior by a single plug-in connector. Each relay shall be capable of direct on/off control by low voltage (intelligent) switch. A means to override this feature shall be provided at the panel. System to have means to provide alternate inputs (building automation system, time clock, photocell, occupancy), to relay groups/zones. Provide additional modules, power supplies, controllers, and interfaces to provide this function as indicated on plans. System shall be capable of accepting inputs from devices of other manufactures via contact closure.

Master stations shall provide a manual means to activate/deactivate all zones as indicated on plans. Systems shall have the capability of interfacing with a Windows based graphical user based application or a touch screen controller.

System shall have a means to allow offsite control via a modem or TCP/ICP protocol.

System shall have a flash waving feature to notify user of shutdown prior to deactivating zone.

System shall have a means to sense loss of power and automatically activate identified emergency circuits served by auxiliary power sources (Generators, UPS’s or Inverters).

Power Supply: Panels shall include a transformer assembly providing power to relays. Provide additional transformers for associated low voltage switches and timers. Transformers include internal over current protection with automatic reset and metal oxide varistor protection against powerline spikes. 120 VAC, 50/60 Hz. +/- 10%.

Cover: Surface with captive screws in a hinged, lockable configuration. A wiring schedule directory card shall be affixed to the cover's back to allow identification of circuits/relays/loads controlled when the door is open.

Switch Stations: Remote switch stations shall consist of two wire relay switches with LED indicating lamps to indicate ON and OFF states. Switch construction shall permit labels to be placed beneath cover to describe function. Construction shall be modular to permit multiple switches in a single yolk and gangable. Switches at each remote location shall be grouped into a single backbox with a common factory stainless steel cover.

Master Stations: Master stations shall consist of two wire relay switches for each relay lighting group specified. Each relay switch shall have LED indicating lamps to indicate ON and OFF states. Switch construction shall permit labels to be placed beneath cover to describe function. Construction shall be modular to permit multiple switches in a single yolk and gangable. Switches at the master station shall be grouped into a single backbox with a common factory stainless steel cover

Relay Group Controller: Lighting relay groups, as indicated on the Drawings, shall be controlled collectively by a relay group controller. Controllers shall be solid state and have up to 24 relay outputs for controlling individual lighting branch circuits. Controllers shall be controlled by a relay or by time clock. Controller shall include control for (4) distinct activation and deactivation of zone events.

Time Clock: Clocks providing automatic control of lighting relay groups shall have a minimum of 8 outputs that are individually programmable. Clocks shall have astronomical control permit 20 distinct holiday schedules per calendar year. Program memory shall be indefinite for all outputs and power loss protection shall maintain accurate time at the clock for a minimum of 48 hours.

PART 3 - EXECUTION

EXAMINATION

Examine areas and conditions under which lighting control equipment is to be installed and notify A-E in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

INSTALLATION OF LIGHTING CONTROL EQUIPMENT

Install lighting control system components and ancillary equipment as indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that lighting control equipment complies with requirements. Comply with requirements of NEC, and applicable portions of NECA's "Standard of Installation" pertaining to general electrical installation practices.

Coordinate with other electrical work, including raceways, and electrical boxes and fittings, as necessary to interface installation of lighting control equipment work with other work.

Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486A and B.

GROUNDING

Provide equipment grounding connections for lighting control equipment as indicated. Tighten connectors to comply with tightening torques specified in UL Std. 486A to assure permanent and effective grounding.

FIELD QUALITY CONTROL

Subsequent to connecting wires/cables, energize contactor circuitry and demonstrate functioning of equipment in accordance with requirements; where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

ADJUSTING AND CLEANING

Inspect electrical contactor's operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.

Touch-up scratched or marred surfaces to match original finish.

TESTING & DOCUMENTATION

Provide verification of proper installation of components and systems as outlined in Section 260596, Lighting Systems Commissioning. Provide all necessary components to properly demonstrate operation of equipment to engineer.

OPERATIONS AND MAINTENANCE MANUAL

Manuals shall include product data for all installed products that identifies all selected options for each component of lighting controls system.

Identify manufacturer's requirements and recommendations for routine maintenance actions, recalibration and cleaning. Identify schedule for items above.

Provide a narrative of the system operation, specific to the installation, including the actual set points.

TRAINING

Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:

Train Owner's maintenance personnel on troubleshooting, servicing, adjusting, and preventive maintenance. Provide a minimum of 16 hours of training.

Training Aid: Use the approved final version of maintenance manuals as a training aid.

Schedule training with Owner, through A-E, with at least seven days' advance notice.

WARRANTY PERIOD

Warranty period for relay panels shall be one year, beginning upon acceptance of the installation by the Owner. Include up to two site visits within the first year, upon request by the Owner, to adjust programming and controls to suit actual conditions.

END OF SECTION 260924

SECTION 262200 – LOW VOLTAGE TRANSFORMERS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Manufacturers: Firms regularly engaged in manufacture of low voltage transformers, of types and ratings required in this Section, whose products are Listed and Labeled for the purpose intended. Subject to compliance with requirements provide equipment equivalent to that provided by one of the following manufacturers:

Square-D Company
Cutler-Hammer
General Electric
Siemens

Codes and Standards:

NEC Compliance: Comply with NEC as applicable to installation and construction of electrical dry type transformers.

NEMA Compliance: Comply with requirements NEMA ST20 for manufacture and testing. Transformers losses shall conform to NEMA TP1 requirements and be tested in accord with NEMA TP2 procedures.

ANSI Compliance: Comply with applicable requirements of ANSI Standards C57-Series pertaining to power/distribution transformers.

Testing Laboratory Compliance: Comply with applicable requirements of ANSI/UL 1561, "Dry-type general purpose and power transformers." Provide dry type transformers and components that are Listed and Labeled.

IEEE Compliance: Comply with requirements of IEEE C57.12.50 “Requirements for Ventilated Dry-Type Distribution Transformers” for standard transformers, and IEEE C57.110 for K-rated transformers.

CFR Compliance: Comply with energy efficiency requirements of Code of Federal Regulations Title 10, Chapter II Part 431, Subpart K “Distribution Transformers”.

SUBMITTALS

Submittals shall be made in strict accordance with the requirements of Section 019913. Specific submittal requirements are defined in each section of this Division.

Product Data: Submit manufacturer's technical product data including rated kVA, frequency, primary and secondary voltages, percent taps, polarity, impedance and certification of transformer performance efficiency at indicated loads, percentage regulation at 100% and 80% power factor, no-load and full-load losses in watts, % impedance at 75ºC, hot-spot and average temperature rise above 40ºC ambient temperature, sound level in decibels, and standard published data.

Shop Drawings: Submit manufacturer's drawings indicating dimensions, and weight loadings for transformer installations, showing layouts, wall bracket mountings and supports, spatial relationship to panelboards and associated equipment, include transformer connections to electrical equipment.

PART 2 - PRODUCTS

DRY TYPE TRANSFORMERS

General: Except as otherwise indicated, provide manufacturer's standard materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for complete installation.

Dry-Type Distribution Transformers: Provide factory-assembled, energy efficient, ventilated, dry-type distribution transformers where shown with size, characteristics, and ratings as indicated on Drawings. Transformers shall be 3-phase, 60-Hz, 3.5% to 5.8% impedance range with 480 Volt delta-connected, 10 kV BIL primaries and 208Y/120 Volt secondaries. Provisions shall be made for neutral grounding. Provide primary windings with 6 taps; 2, 2-1/2% increments above full-rated voltage and 4, 2-1/2% increments below full-rated voltage for de-energized tap-changing operation. Transformers shall be insulated with Class 220 insulation. Transformer shall be rated for continuous operation at 130% of rated kVA. Transformer shall have a temperature rise limitation of 80^{o}C. maximum. Provide terminal enclosure, with hinged cover, to accommodate primary and secondary coil wiring connections and electrical supply raceway terminal connector. Provide terminal board with clamp type connectors. Limit terminal compartment temperature to 75^{o}C when transformer is operating continuously at rated load with ambient temperature of 40^{o}C. Provide wiring connections suitable for copper wiring.

Integrally mount vibration isolation supports between core and coil assembly and transformer enclosure; electrically ground core and coils to transformer enclosure by means of flexible metal grounding strap sized in accordance with applicable UL and NEC standards. There shall be no other metal-to-metal contact between the core and coil and the enclosure.

Transformer primary and secondary coils shall be of the continuous wound construction and shall be impregnated with non-hygroscopic, thermosetting varnish.

Transformer core shall be constructed with low hysteresis and eddy current losses. Magnetic flux densities shall be kept well below the saturation point to prevent core overheating.

Transformer core and coil assembly shall be bolted to the base of the enclosure but isolated by means of rubber vibration-absorbing mounts. Do not exceed maximum sound-level rating of 50 db as determined in accordance with ANSI/NEMA standards. Sound isolation systems requiring the complete removal of all fastening devices will not be acceptable.

The core and coil assembly shall be enclosed in a sheet metal housing suitable for indoor installation with ventilating louvers for entrance and arrangement with the high voltage termination on the left when facing the nameplate side of the transformer. Provide transformers with fully-enclosed weather-resistant steel enclosures where transformer is used in outdoor locations or where transformer is exposed to moisture. Provide transformer suitable for floor and/or wall mounting as indicated on the Drawings.

The Transformer Shall Be Furnished Complete With the Following Standard Accessories:

- Stainless steel diagrammatic nameplate
- Provisions for jacking and lifting
- Base suitable for skidding or rolling in any direction
- Removable side sheets
- Ground pad located on low voltage end of the enclosure

Each transformer shall receive all standard commercial tests in accordance with ANSI standard C57.12.90. Each manufacturer shall verify that the design proposed meets or exceeds the short circuit requirements of the ANSI standard C57.12.90 by submitting copies of test results from short circuit tests on similar design units.

Finishes: Coat interior and exterior surfaces of transformer, including bolted joints, with manufacturer's standard light gray outdoor enamel over cleaned and phosphatized steel enclosure.

PART 3 - EXECUTION

INSPECTION

Installer must examine area and conditions under which transformer and ancillary equipment are to be installed, and notify A-E in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

INSTALLATION OF TRANSFORMERS

Install transformers as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NESC, NEMA, ANSI and IEEE standards, and in accordance with recognized industry practices to ensure that products fulfill requirements.

Coordinate transformer installation work with electrical raceway and wire/cable work, as necessary for proper interface.

Install units on vibration mounts; comply with manufacturer's indicated installation method, if any.

Connect transformer units to electrical wiring system with liquidtight flexible conduit; comply with requirements of other Division 26-28 sections.

Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std. 486A and B.

Equipment/System Identification: Provide equipment identification nameplates complying with Section 260533, *ELECTRICAL IDENTIFICATION.*

GROUNDING

Provide equipment grounding connections for transformers as indicated, including ground connection to water pipe and ground connection to grounding rod. Tighten connections to comply with tightening torques specified in UL Std. 486A to assure permanent and effective grounding.

TESTING

Prior to energizing of transformer, check all accessible connections for compliance with manufacturer's torque tightening specifications.

Prior to energizing, check circuitry for electrical continuity, and for short-circuits.

Upon completion of installation of transformer, energize primary circuitry at rated voltage and frequency from normal power source, and test transformer, including, but not limited to, audible sound levels, to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new unit or components, and proceed with retesting.

END OF SECTION 262200

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Manufacturers: Firms regularly engaged in manufacture of panelboards, of types and ratings required in this Section, whose products are Listed and Labeled for the purpose intended. Subject to compliance with requirements provide equipment equivalent to that provided by one of the following manufacturers:

- Square-D Company
- Cutler Hammer
- Siemens
- General Electric

Codes and Standards:

Electrical Code Compliance: Comply with applicable State code requirements of the authority having jurisdiction and NEC Article 408 as applicable to installation and construction of electrical panelboards and enclosures.

Testing Laboratory Compliance: Comply with applicable requirements of Std. No. 67, "Electric Panelboards," and Stds No.'s 50, 869, 486A, 486B, 489, and 1053 pertaining to panelboards, circuit breakers, accessories and enclosures. Provide units that are Listed and Labeled.

Special-Use Markings: Provide panelboards, constructed for special-use, with appropriate Listed marks that indicates that they are suitable for special type of use/application including service entrance equipment.

NEMA Compliance: Comply with NEMA Stds. Pub./No. 250 "Enclosures for Electrical Equipment (1000 Volts Maximum)," Pub/No. PB 1, "Panelboards," and Pub/No. PB 1.1, "Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less."

SUBMITTALS

Submittals shall be made in strict accordance with the requirements of Section 019913. Specific submittal requirements are defined in each section of this Division.

Product Data: Submit manufacturer's data on panelboards and enclosures.

Submit Time-Current Timing Charts: Provide response curves for all overcurrent protection devices furnished as a part of the project. Provide specific circuit breaker and trip unit model numbers for all specified electronic trip breakers, with available settings for engineer’s use in developing system coordination.

PART 2 - PRODUCTS

PANELBOARDS:

General: Except as otherwise indicated, provide panelboards, bolt-on breakers, integral common trip, enclosures and ancillary components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials. Panelboards shall be designed and constructed in accordance with published product information. Equip with proper number of unit panelboard devices as required for complete installation. Where types, sizes, or ratings are not indicated, comply with NEC, UL and established industry standards for those applications indicated.

Distribution Panelboards: Provide factory assembled, dead front safety constructed, power distribution panelboards with circuit breaker type in sizes and ratings indicated. Provide panelboard switching and protective devices in quantities, ratings, types, characteristics and with arrangement indicated. Provide with anti-turn solderless pressure type main lug connections approved for use with copper conductors. Construct with rectangular shaped bus bars of solid copper, with conductivity not less than 98%. Bus bars shall be securely mounted and braced and have solderless lugs bolted to main bus bars. Panelboards shall have full sized neutral bus and full sized bare un-insulated ground bus suitable for bolting to enclosures.

Panelboards shall have voltage ratings suitable for service voltage at which they will be used. Provide suitable lugs on neutral bus for outgoing feeders requiring neutral connections. Provide molded case bolt-on type main circuit breaker with toggle handles that indicate when tripped where Main Circuit Breaker (MCB) panelboards are indicated. Provide bolt-on circuit breaker types with toggle handles that indicate when tripped for each indicated branch or feeder circuit.

Where multiple pole breakers are indicated, provide with integral common trip so that overload on one pole will trip all poles simultaneously. Select enclosures, as noted on Drawings, fabricated by same manufacturer as panelboards and which mate and match properly with panelboards.

Branch Circuit Panelboards: Provide factory assembled, dead front safety constructed, branch circuit panelboards of the circuit breaker type, in sizes and ratings indicated. Provide panelboard switching and protective devices in quantities, ratings, types, characteristics and with arrangement indicated. Panelboards shall be equipped with anti-turn solderless pressure type main lug connections approved for use with copper conductors. Construct panelboards with rectangular shaped bus bars of solid copper, with conductivity not less than 98%, which are securely mounted and braced, and with solderless lugs bolted to main bus bars. Panelboards specified with dual lugs for sub-feed shall include dual lugs for each phase at the point of termination. Feed-through bus arrangements are not acceptable.

Panelboards shall have full sized neutral bus and bare un-insulated ground bus suitable for bolting to enclosures. Panelboards shall have voltage ratings suitable for service voltage at which they will be used. Provide suitable lugs on neutral bus for outgoing feeders requiring neutral connections. Provide molded case main and branch circuit bolt-on breaker types for each circuit, with toggle handles that indicate when tripped. Branch circuit breakers for switching lighting circuits shall be Type “SWD”’ those used for switching high intensity discharge lighting circuits, Type “HID”.

Provide branch circuit panelboards with a maximum 42 branch circuit breaker positions. Where multiple pole breakers are indicated, they shall be provided with integral common trip so that overload on one pole will trip all poles simultaneously. Select enclosures, as noted on Drawings, fabricated by same manufacturer as panelboards and which mate and match properly with panelboards.

Panelboard Enclosures: Provide galvanized sheet steel cabinet type enclosures, in sizes and NEMA types as indicated, code-gage, minimum 16-gage thickness. Construct with no knockouts and code sized wiring gutters. Design enclosures for recessed or surface mounting as indicated on Drawings. Provide enclosures that are fabricated by same manufacturer as panelboard and which mate properly with panelboards to be enclosed.

Panelboard Fronts: Provide panelboard fronts with adjustable trim clamps, and doors with flush locks and keys. All locks for panelboard enclosures shall be keyed alike. Panelboard fronts shall be constructed with concealed piano door hinges and provided with baked gray enamel finish over a rust inhibitor coating. Panel doors are left hand doors unless otherwise indicated on the Drawings. Panelboard front shall be secured to the enclosure by the use of screws.

Provided hinged-type access for all panelboard doors so that access to the interior of the panelboard can be gained without the necessity of physically removing the panelboard cover.

Equip panelboard fronts with interior circuit directory frame, and card with clear plastic covering. Information from panel schedules shall be typed on the directory card. Hand lettering of directory cards is not acceptable.

Molded Case Circuit Breakers: Provide factory assembled, molded case circuit breakers of frame sizes, characteristics, and ratings including RMS symmetrical interrupting ratings indicated. Select breakers with permanent thermal and instantaneous magnetic trip, and with fault current limiting protection, ampere ratings as indicated. Construct with overcenter, trip free, toggle type operating mechanisms with quick-make, quick-break action and positive handle trip indication. Construct breakers for mounting and operating in any physical position in an ambient temperature of 40°C. Provide breakers with mechanical screw type removable connector lugs, AL/CU rated.

Circuit Breaker Lugs: Provide circuit breaker lugs to match feeder conductors or branch circuit conductors as indicated on the Drawings. In general, the ampere rating of circuit breakers is selected to support the requirements of the load. In cases where circuit conductor size has been increased for improved voltage drop, or other reasons, provide increased lug size as needed to match increased conductor size. Provide larger circuit breaker frame size if same is required to accommodate increased conductor size as described above.

Fully Rated Circuit Breakers: Series rated circuit breakers are not permitted. Provide fully rated circuit breakers unless specifically indicated otherwise on the Drawings.

Electronic Trip Circuit Breakers: Provide electronic trip units for main breakers 500 Amps and larger and branch breakers 400 Amps and larger, with field-replaceable rating plug and RMS sensing, responsive to current in each pole. Provide following field-adjustable settings:

1. Instantaneous trip.
2. Long and short-time pickup levels.
3. Long and short-time delay adjustments.

Provide ground fault pickup for breakers rated 1,000 amps and larger, where unit serves as a main disconnecting means, as required under NEC.

1. Ground-fault pickup level, time delay and I^2t response.

Energy Reduction Provisions: Provide breakers rated at 1,200 Amps and larger with maintenance switch and associated indicator light to permit the reduction of arc energy at and beyond the load side terminals for the breaker.

Special Purpose Circuit Breakers: Where indicated, provide circuit breakers with the following additional features:

1. Ground-Fault Circuit Interrupter (GFCI), UL 943, single-and two-pole configurations with //5//30//-mA trip sensitivity with Ampere rating as indicated on panelboard schedule. Breaker shall also be listed to UL 489 for molded case circuit breakers.

2. Arc-Fault Circuit Interrupter (AFCI), UL 1699, for protection of branch circuit wiring, rated 15 or 20 Amps as indicated on panel schedule. Breaker shall also be listed to UL489 for molded case circuit breakers.

Circuit Breaker Positions: Circuit breaker positions are indicated on panel schedules in the Drawings. Indicated positions are mandatory unless changes are specifically approved in writing by the A-E.

Panelboard submittals shall not be used as a means of obtaining approval for alternate circuit breaker positions.

Panelboard Accessories: Provide panelboard accessories and devices including, but not necessarily limited to, cartridge and plug time-delay type fuses, circuit-breakers, ground-fault protection units, lugs, grounding terminations, labels, etc., as recommended by panelboard manufacturer for ratings and as indicated on the Drawings.

Short Circuit Rating: Unless otherwise indicated, panelboards and all devices shall have a minimum short circuit withstand rating of 10,000 RMS symmetrical Amperes.

PART 3 - EXECUTION

EXAMINATION

Examine areas and conditions under which panelboards and enclosures are to be installed, and notify A-E in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

INSTALLATION OF PANELBOARDS

General: Install panelboards and enclosures as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC standards and NECA's "Standard of Installation," and in compliance with recognized industry practices to ensure that products fulfill requirements.

Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486A and B.

Fasten enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically anchored.

Provide properly wired electrical connections for panelboards within enclosures.

Fill out panelboard's circuit directory card with typewriter upon completion of installation work. Circuit descriptions shall match those on the panel schedule in the Drawings.

Equipment/System Identification: Provide equipment identification nameplates complying with Section 260533, *ELECTRICAL IDENTIFICATION*.

GROUNDING

Provide equipment grounding connections for panelboards as indicated. Tighten connections to comply with tightening torques specified in UL Stds 486A to assure permanent and effective grounds. All panelboards shall be grounded with an insulated grounding conductor routed with the panel feeder. The grounding conductor shall be bonded to the panel grounding bus and a bonding bushing on the panelboard feeder raceway.

FIELD QUALITY CONTROL

Prior to energizing electrical circuitry, check all accessible connections to manufacturer's tightening torque specifications.

Prior to energizing panelboards, check with resistance tester phase-to-phase and phase-to-ground insulation combinations to ensure insulation and continuity requirements are fulfilled.

Prior to energizing, check panelboards for electrical continuity of circuits, and for short-circuits.

ADJUSTING AND CLEANING

Adjust operating mechanisms for free mechanical movement.

Touch-up scratched or marred surfaces to match original finishes.

DEMONSTRATION

Subsequent to wire and cable hookups, energize panelboards and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Manufacturers: Firms regularly engaged in manufacture of wiring devices, of types and ratings required in this Section, whose products are Listed and Labeled for the purpose intended. Subject to compliance with requirements provide devices equivalent to that provided by one of the following manufacturers:

Hubbell
Cooper Devices
Leviton
Pass & Seymour

Codes and Standards:

NEC Compliance: Comply with NEC as applicable to installation and wiring of electrical wiring devices.

Testing Laboratory Compliance: Comply with applicable requirements of UL 20, 486A, 498, and 943 pertaining to installation of wiring devices. Provide wiring devices that are Listed and Labeled.

NEMA Compliance: Comply with applicable portions of NEMA Standards No. WD 1, "*General Purpose Wiring Devices*", WD 2, "*Semiconductor Dimmers for Incandescent Lamps*", and WD 5, "*Specific Purpose Wiring Devices*".

SUBMITTALS

Submittals shall be made in strict accordance with the requirements of Section 019913. Specific submittal requirements are defined in each section of this Division.

Product Data: Submit manufacturer's data on electrical wiring devices.

PART 2 - PRODUCTS

FABRICATED WIRING DEVICES

General: Provide factory fabricated wiring devices in types, colors, and electrical ratings for applications indicated and which comply with NEMA WD 1.

"Specification" grade devices, as used in this section shall be "Federal Specification" grade devices.

Color: Provide white color devices unless indicated otherwise for selected locations elsewhere in the Specifications or on the Drawings.

Provide red face devices in all cases where receptacles are supplied from a generator derived power source.

Provide blue face for self-contained surge protected devices.

Receptacles:

General-Use Duplex: Provide duplex specification grade, tamper resistant type receptacle, 2-pole, 3-wire, grounding, with green hexagonal equipment ground screw, high impact nylon face, ground terminal, brass triple wipe contacts, 20 Ampere rated, 125-volts, with metal plaster ears. Provide receptacles with grounding terminal internally connected to mounting yoke. Receptacles shall be designed for side and back wiring with spring-loaded, screw activated pressure plates, with NEMA configuration 5-20R unless otherwise indicated.

General-Use Simplex: Provide single specification grade, tamper resistant type receptacle, 2-pole, 3-wire, grounding, with green hexagonal equipment ground screw, high impact nylon face, ground terminal, brass triple wipe contacts, 20 Ampere rated, 125 volts, with metal plaster ears. Provide receptacles with grounding terminal internally connected to mounting yoke. Receptacles shall be designed for side and back wiring with spring-loaded, screw activated pressure plates, with NEMA configuration 5-20R unless otherwise indicated.

Ground-Fault Interrupter: Provide specification grade, tamper resistant type ground-fault circuit interrupter, with heavy-duty duplex receptacles capable of being installed in a 1-1/2" deep outlet box without adapter. Ground fault interrupter receptacles shall be grounding type, UL Class A, Group 1, 20 ampere rated, 120-volts, 60 Hz, with high impact nylon face, brass triple wipe contacts, and solid-state ground-fault sensing and signaling. Devices shall have 5 milliamperes ground-fault trip level and shall be equipped with NEMA configuration 5-20R.

Special Receptacles: Provide special receptacles with NEMA configuration, voltage rating, current rating, and other attributes as indicated on the Drawings in Receptacle Schedules, General Notes, Keyed Notes, or other designations.

Receptacles provided are to be either straight blade, locking type, or pin type as indicated. All receptacles are to be equipped with green hexagonal equipment ground screw, brass triple wipe contacts and brass connector screws.

Receptacles shall be designed for both side and back wiring with spring-loaded and screw activated pressure plates where such are available in the device type indicated.

All 15- and 20-ampere, 125- and 250-volt, non-locking (straight blade) receptacles specified in areas identified in NEC 406.12 shall be tamper resistant type.

Cord Reel Assembly: Provide cord reel assembly at locations indicated on the Drawings. Assembly housing shall be all steel construction with mounting base and powder coat finish, rated for indoor use. Assembly shall include 50 foot retractable cord, terminated with pre-wired outlet box containing two duplex (5-20R) receptacles. Conductors shall be 12 AWG, black Type SJOW. Cord shall have adjustable ball stop and cord assembly shall be capable of both positive lock and constant tension operation.

Explosion Proof Receptacle: Provide two gang receptacle assembly rated for Class 1, Division 2 with two receptacles, 20-Ampere rated, 125-Volts, and Provide with neoprene gasketed spring door covering and die-cast copper free housing.

Miscellaneous Features:

Provide the following additional receptacle features where such is required by code or indicated on the drawings:

Surge protected

Weather resistant (WR) for all general use and ground fault interrupter receptacles installed in damp and wet locations.

Duplex receptacles with two vertical USB ports. Ports shall provide 3.0 minimum amps charging capacity and include LED indicator light to indicate presence of USB power (5 VDC). Ports shall be compatible with USB 2.0 and 3.0 devices

Switches:

Snap: Provide heavy-duty, specification grade, flush single-pole AC quiet toggle switches, 20 Amperes, 120-277 Volts AC, with silver cadmium oxide contacts, brass terminal screws, and mounting yoke insulated from mechanism. Equip switches with plaster ears, switch handle, and green hexagonal equipment grounding screw. Switches shall be designed for side and back wiring with spring-loaded, screw activated pressure plates.

Duplex Snap: Provide heavy duty, specification grade, flush dual single pole AC quiet switches, 20 Amperes, 120-277 Volts, with silver cadmium oxide contacts, brass terminal screws, and mounting yoke insulated from mechanism. Equip switches with plaster ears, switch handles, green hexagonal equipment grounding screw and side wired screw terminals with break-off tab feature that allows wiring with separate or common feed.

Two Pole Snap: Provide heavy duty, specification grade, flush two pole AC quiet switches, 20 Amperes, 120-277 Volts, with silver cadmium oxide contacts, brass terminal screws, and mounting yoke insulated from mechanism. Equip switches with plaster ears, switch handle, green hexagonal equipment grounding screw and side wired screw terminals.

Three Way: Provide heavy-duty, specification grade, flush 3-way AC quiet switches, 20 Amperes, 120-277 Volts, with silver cadmium oxide contacts, brass terminal screws, and mounting yoke insulated from mechanism. Equip switches with plaster ears, switch handle, green hexagonal equipment grounding screw. Switches shall be designed for side and back wiring with spring-loaded, screw activated pressure plates.

Four Way: Provide heavy-duty, specification grade, flush 4-way AC quiet switches, 20 Amperes, 120-277 Volts, with silver cadmium oxide contacts, brass terminal screws, and mounting yoke insulated from mechanism. Equip switches with plaster ears, switch handle, green hexagonal equipment grounding screw. Switches shall be designed for side and back wiring with spring-loaded, screw activated pressure plates.

Lighted Handle Snap: Provide heavy duty, specification grade, flush single pole AC quiet lighted handle toggle switches with silver cadmium oxide contacts and brass terminal screws in any of the pole configurations indicated above. Switches shall be equipped with plaster ears, have side wired screw terminals, and a 20 Amperes, 120-277 Volts rating. Lighted handle shall be illuminated when the switch is in the open position.

Pilot Light Handle Snap: Provide heavy duty, specification grade, flush single pole AC quiet pilot light handle toggle switches with silver cadmium oxide contacts and brass terminal screws in any of the pole configurations indicated above. Switches shall be equipped with plaster ears, have side wired screw terminals, and a 20 Amperes, 120-277 Volts rating. Lighted handle shall be illuminated when the switch is in the closed position.

Explosion Proof: Provide 120V, heavy duty, specification grade, single pole snap switch mounted within a surface mounted enclosure rated for Class 1, Division 2 locations. Enclosure shall prevent arcing of enclosed switch from causing ignition of gases within space switch is located. Entire assembly shall be third party listed.

Miscellaneous Features:

Provide the following additional switch features where such is indicated on the drawings:

Key operation; supply one key per switch.

0-10 Volt Dimmers: Provide specification grade, preset type slide control, single pole branch lighting solid state 0-10 Volt DC dimmer control for LED source fixtures. Dimmers shall be designed for side and back wiring with spring-loaded, screw activated pressure plates where such are available. Wattage shall be a minimum of 125% of the connected load unless otherwise specified on the Drawings. Dimmer shall be compatible with fixture driver/ballast in coordination with light fixture package provided.

WIRING DEVICE ACCESSORIES

Wallplates for Flush Mounted Devices: Provide standard sized phenolic wallplates for flush mounted single and combination wiring devices of types, sizes, and with ganging and cutouts as required for the application. Select plates that mate and match wiring devices to which attached; provide blank plates for empty or unused boxes. Provide screws for securing plates to devices; screw heads shall match finish of plates. Oversized plate shall not be used unless specifically permitted by the A-E. A quantity of 2% spare plates shall be provided for the Owner.

Wallplates for Surface Mounted Devices: Provide steel plates as required to match device box construction.

Wallplates for exterior and/or wet locations: Provide weatherproof PVC products listed as "extra duty while in use." Covers shall be rectangular, transparent high-impact, UV-resistant polycarbonate.

CONTACTORS

General: Except as otherwise indicated, provide contactors and ancillary components that comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation.

Kitchen Equipment Contactors: Provide full voltage alternating current contactor, of types, sizes, ratings, and NEMA sizes indicated. Equip contactors with mechanically held contacts. Construct and mount starters in NEMA Type 1 enclosure; coat with manufacturer's standard color finish.

PART 3 - EXECUTION

INSTALLATION OF WIRING DEVICES

Install wiring devices as indicated in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices to fulfill project requirements.

Coordinate with other work, including painting, electrical boxes and wiring work, as necessary to interface installation of wiring devices with other work.

Install wiring devices only in electrical boxes that are clean, free from excess building materials, dirt, and debris.

Install wiring devices after wiring work is completed.

Install wallplates after painting work is completed.

Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for wiring devices. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torque’s specified in UL Stds 486A and B. Use properly scaled torque indicating hand tool.

PROTECTION OF WALLPLATES AND RECEPTACLES

Upon installation of wallplates and receptacles, advise other project Contractors regarding proper and cautious use of convenience outlets. At time of Substantial Completion, replace those items that have been damaged, including those burned and scored by faulty plugs.

GROUNDING

Provide equipment grounding connections for all wiring devices, unless otherwise indicated. All devices, including switches, shall be grounded by an individual insulated green equipment grounding conductor connected to the grounding conductor that is run with the ungrounded conductors, and attached to the device box. Comply with tightening torque's specified in UL Std. 486A to assure permanent and effective grounds.

TESTING

Prior to energizing circuitry, test wiring for electrical continuity, and for short-circuits. Ensure proper polarity of connections is maintained. Subsequent to energizing, test wiring devices to demonstrate compliance with requirements.

FIELD QUALITY CONTROL

Subsequent to completion of installation of electrical disconnect switches, energize circuitry and demonstrate capability and compliance with requirements. Correct any faults to assure compliance with requirements. Retest to demonstrate compliance. Devices that fail to comply with requirements shall be removed and replaced with new units. Retest all replaced devices.

END OF SECTION 262726

SECTION 262816 – ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

SUMMARY

This section includes fusible switches, non-fusible switches, molded case circuit breakers and enclosures.

QUALITY ASSURANCE

Manufacturers: Firms regularly engaged in manufacture of electrical switches and circuit breakers, of types and ratings required in this Section, whose products are Listed and Labeled for the purpose intended. Subject to compliance with requirements provide equipment equivalent to that provided by one of the following manufacturers:

Square D
Cutler Hammer
General Electric
Siemens

Codes and Standards:

NEC Compliance: Comply with NEC requirements pertaining to construction and installation of electrical switches and circuit breakers.

Testing Laboratory Compliance: Comply with applicable requirements of UL 489, “Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker enclosures pertaining to circuit breakers, accessories and enclosures. Provide units that are Listed and Labeled.

Special-Use Markings: Provide enclosed circuit breakers, constructed for special-use, with appropriate Listed marks that indicates that they are suitable for special type of use/application including service entrance equipment.

Testing Laboratory Compliance: Comply with requirements of UL 98, "*Enclosed and Dead-Front Switches*". Provide safety switches that have been Listed and Labeled.

NEMA Compliance: Comply with applicable requirements of NEMA Standard Publication No. KS 1, "*Enclosed Switches*" and 250, "*Enclosures for Electrical Equipment (1000 Volts Maximum)*."

SUBMITTALS

Submittals shall be made in strict accordance with the requirements of Section 019913. Specific submittal requirements are defined in each section of this Division.

Product Data: Submit manufacturer's data on electrical switches and circuit breakers.

Submit Time-Current Timing Charts: Provide response curves for all overcurrent protection devices furnished as a part of the project. Provide specific circuit breaker and trip unit model numbers for all specified electronic trip breakers, with available settings for engineer’s use in developing system coordination.

PART 2 - PRODUCTS

MOLDED CASE CIRCUIT BREAKERS

Thermal Magnetic Circuit Breakers: Provide factory assembled, molded case circuit breakers of frame sizes, characteristics, and ratings including RMS symmetrical interrupting ratings indicated. Select breakers with permanent thermal and instantaneous magnetic trip, and with fault current limiting protection, ampere ratings as indicated. Construct with overcenter, trip free, toggle type operating mechanisms with quick-make, quick-break action and positive handle trip indication. Construct breakers for mounting and operating in any physical position in an ambient temperature of 40°C. Provide breakers with mechanical screw type removable connector lugs, AL/CU rated.

Electronic Trip Circuit Breakers: Provide electronic trip units for breakers 400 Amps and larger, with field-replaceable rating plug and RMS sensing, responsive to current in each pole. Provide following field-adjustable settings:

1. Instantaneous trip.
2. Long-and short-time pickup levels.
3. Long-and short-time delay adjustments.

Provide ground fault pickup for breakers rated 1,000 Amps and larger, where unit serves as a main disconnecting means, as required under NEC.

1. Ground-fault pickup level, time delay, and I^2t response.

Energy Reduction Provisions: Provide breakers rated at 1,200 Amps and larger with maintenance switch and associated indicator light to permit the reduction of arc energy at and beyond the load side terminals for the breaker.

Circuit Breaker Lugs: Provide circuit breaker lugs to match feeder conductors as indicated on the Drawings. In general, the ampere rating of circuit breakers is selected to support the requirements of the load. In cases where circuit conductor size has been increased for improved voltage drop, or other reasons, provide increased lug size as needed to match increased conductor size. Provide larger circuit breaker frame size if same is required to accommodate increased conductor size as described above.

Special Purpose Circuit Breakers: Where indicated, provide circuit breakers with the following additional features:

1. Ground-Fault Circuit Interrupter (GFCI), UL 943, single-and two-pole configurations with 5-mA trip sensitivity with Ampere rating as indicated on the Drawings. Breaker shall also be listed to UL 489 for molded case circuit breakers.

2. Shunt Trip Provisions: Provide breakers with trip coil energized from separate circuit, with coil-clearing contacts.

Provide NEMA Type 1 enclosure unless otherwise indicated on the Drawings; provide NEMA Type 3R enclosure where the Drawings indicate weatherproof. Other enclosure types shall be furnished if specifically indicated on the Drawings.

FABRICATED SWITCHES

Safety Switches: Provide surface-mounted, heavy duty, steel enclosed safety switches, of types, voltage rating, current rating, and number of poles indicated on the Drawings.

Switches with no drawing indication of number of poles are three pole types. Switches shall be fusible type, rated as follows unless otherwise specified:

For 480Y/277 V.: Use 600 Volt type, with neutral and grounding bus.

For 208Y/120 V.: Use 250 Volt type, with neutral and grounding bus.

For 120/240 V.: Use 250 Volt type, with neutral and grounding bus.

Provide internally mounted, insulated, neutral bus suitable for copper conductors. Provide separate equipment grounding bus, bonded to the enclosure and marked for use as a grounding bus.

Provide horsepower rated switches incorporating quick-make, quick-break type switches constructed so that switch blades are visible in OFF position with door open. Equip with operating handle which is integral part of enclosure base and whose operating position is easily recognizable. Internal current carrying components shall be high-conductivity copper; switch contacts shall be silver-tungsten type. Fuse holders shall have positive pressure type reinforced fuse clips. Where non-fused disconnect switches are indicated, provide solid copper bus bars in lieu of fuses.

Provide NEMA Type 1 enclosure unless otherwise indicated on the Drawings; provide NEMA Type 3R enclosure where the Drawings indicate weatherproof. Other enclosure types shall be furnished if specifically indicated on the Drawings.

Provide switches that may be locked in either the “ON’ or ‘OFF’ condition with a 1/4" shackle hasp-type lock. Safety switches shall have door interlocks that prevent the door from opening when the operating handle of the switch is in the “on” position. Manual defeat mechanisms shall be provided for the interlocks.

Provide two-pole interlock switches for all disconnects that are used with utilization equipment requiring control connections provided under other divisions. The interlock switch is to be configured such that when the disconnect is open the interlock switch is open.

Provide additional interlock switches, auxiliary contacts, mechanical key interlocks, or other accessories as may be described by the Drawings.

Fuses: Provide fuses for safety switches of classes, types, and ratings needed to fulfill electrical requirements of Divisions 26-28 supplied utilization equipment served by the safety switch. Dual element fuses shall be cartridge type with ferrule contact or knife-blade contact type as appropriate.

Fuses for equipment supplied by other divisions are to be furnished and installed by the division supplying the equipment.

Fuses are not to be installed by this contractor unless the equipment served by the disconnect is furnished under Divisions 26-28.

PART 3 - EXECUTION

INSTALLATION OF ENCLOSED SWITCHES AND CIRCUIT BREAKERS

Install electrical switches and circuit breakers as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation," and in accordance with recognized industry practices.

Coordinate electrical switches and circuit breakers installation work with electrical raceway and cable work, as necessary for proper interface. Coordinate exact location of switches with equipment electrical connection point.

Locate electrical switches and circuit breakers so that they are accessible after all project elements are installed. Location selected for switches must permit complete opening of the disconnect door or cover to the maximum amount permitted by the design of the switch enclosure.

Install electrical switches and circuit breakers for use with motor-driven appliances, and motors and controllers within sight of controller position unless otherwise indicated.

Provide GFI circuit breakers with 30 mA sensitivity trip for all freeze protection, temperature maintenance, and heat tracing circuits.

GROUNDING

Provide equipment grounding connections, sufficiently tight to assure a permanent and effective ground, for electrical switches and circuit breakers. All electrical switches and circuit breakers shall be grounded by means of a separate insulated grounding conductor, run with the ungrounded conductors, and bonded to the disconnect enclosure by means of a dedicated grounding screw terminal or bus.

FIELD QUALITY CONTROL

Subsequent to completion of installation of electrical switches and circuit breakers, energize circuitry and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at project site, then retest to demonstrate compliance; otherwise remove and replace with new units and retest.

END OF SECTION 262816

SECTION 265100 - LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section

1.2 SUMMARY

A. Section Includes:

1. Interior luminaires with LED technology.
2. Lighting fixture supports.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaires.
4. Include emergency lighting units, including batteries and chargers.
5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing and Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps and accessories identical to those indicated for the lighting fixture as applied in this Project IES LM-79 and IES LM-80.

a. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

B. Shop Drawings: For nonstandard or custom luminaires and where requested for in the fixture schedule.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Product Schedule: For luminaire, see schedule on contract drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Lighting luminaires.
2. Suspended ceiling components.
3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches of the plane of the luminaires.
4. Structural members to which luminaires will be attached.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

C. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Product Certificates: For each type of luminaire.

E. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.

F. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
2. Diffusers and Lenses: Two for every 100 of each type and rating installed. Furnish at least one of each type.
3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

D. Mockups: For interior lighting luminaires in room or module mockups, complete with power and control connections.

1. Obtain Architect's approval of luminaires in mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

A. Refer to Lighting Fixture schedule found on drawings for specific fixture types, requirements, model numbers, etc.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

D. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

E. Recessed Fixtures: Comply with NEMA LE 4.

F. Bulb shape complying with ANSI C79.1.

G. Lamp base complying with ANSI C81.61.

H. CRI of minimum 80. CCT of 4000 K unless otherwise noted on drawings.

I. Rated lamp life of 50,000 hours.

J. Lamps dimmable from 100 percent to 0 percent of maximum light output.

K. Internal driver.

L. Nominal Operating Voltage: 20 V ac.

1. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

M. Housings:

1. Extruded-aluminum housing and heat sink.
2. Anodized finish or as noted on the drawings.

2.2 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools.

Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:

1. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
2. Retain "Glass" Subparagraph below if first, second, third, or fourth option in "Diffusers and Globes" Paragraph above is retained.
3. Glass: Annealed crystal glass unless otherwise indicated on the drawings.
4. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. Anodized finish.

E. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

a. "USE ONLY" and include specific lamp type.
b. Lamp diameter, shape, size, wattage, and coating.
c. CCT and CRI for all luminaires.

2.3 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.4 LUMINAIRE FIXTURE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage.

D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Engineer, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

E. Wall-Mounted Luminaire Support:

1. Attached to a minimum 20 gauge backing plate attached to wall structural members.
2. Do not attach luminaires directly to gypsum board.

F. Ceiling-Mounted Luminaire Support:

1. Ceiling mount with pendant mount with 5/32-inch-diameter aircraft cable supports adjustable to 120 inches in length.

G. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod wire support for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

H. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to 1 visit to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 265100

SECTION 265600 - EXTERIOR LIGHTING

PART 1 - **GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
2. Luminaire poles and supports.

1.2 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color rendering index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including LED source, reflector, and housing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of luminaire and pole.

1. Arrange in order of luminaire designation and pole designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaire.
4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
5. Include UL information of pole in accordance to NCBCC for poles over 12'.
6. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project

    a. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

7. Wiring diagrams for power, control, and signal wiring.
8. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

B. Shop Drawings: For nonstandard, modified or custom luminaires and where requested for in the fixture schedule.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, location and size of each field connection, and cabling for pole mounted fixtures
3. Include diagrams for power, remote power supplies, signal, and control wiring.

C. Delegated-Design Submittal: For the design of the light poles, base plates, anchor rods and the connection to the foundation. Including analysis data signed and sealed by the qualified professional engineer, registered in the state of North Carolina, responsible for their preparation.

1. Submit delegated-design submittal / calculations concurrently with shop drawings.
2. Design Intent: General size, layout, functionality and materials “look and feel” as conveyed by the Lighting Designer’s drawings and fixture schedule and fixture cut sheets.

D. Finish Samples: For each luminaire and for each color and texture indicated with factory-applied finish.

E. Substitution Submittals:

1. Provide full photometric data for luminaire in addition to standard product submittal data.

2. Warranty information.

3. Provide a point by point illuminance calculation on a full site plan to demonstrate that the substitution meets the desired lighting intent. All project luminaires must be shown together on one plan assess impact of substitution.

a. Appropriate light loss factors to be applied to IES files to account for environmental conditions, color temperature and any accessories that lessen lumen output.

b. Proposed trees are to be included in the illuminance calculation.

c. Point grid should be no greater than 5’ x 5’ for pedestrian paths.

d. Show 0.5 iso-footcandle lines (fixture template) for each pole mounted fixture on point by point plan.

e. Include mounting heights and aiming angles for each luminaire.

f. Provide statistical data:
1) Provide average footcandles, minimum footcandles, maximum footcandles, avg. / min. ratio and maximum / minimum ratio for ground plane surfaces.

2) Vertical illuminance calculations need to be provided for both directions of travel along a path or walk. Provide average and minimum footcandles for vertical light calculations. Vertical points are to be located 5' above finished grade.
3) Statistical areas shall be provided for distinct areas such as exterior entries and terraces, walkways, and driveways.

4. Where necessary provide data that assemblies [luminaire, brackets, poles, accessories] withstand wind speed design criteria.

5. Provide UL listing for poles.

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices and supporting structure, applied as stated in AASHTO.

B. Live Load: Calculated and applied as stated in AASHTO.

C. Ice Load: Calculated and applied as stated in AASHTO.

D. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.

1.6 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

D. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

E. Mockups: For exterior luminaires, complete with power and control connections.

1. Obtain Architect's approval of luminaires in mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
5. Subject to compliance with requirements, approved mockups may become part of the completed work if undisturbed at time of Substantial Completion. Mock-up the following fixture types:
    a. ACC01 – Accent Bollard: minimum of (1) fixture to be reviewed. Final locations in plan to be verified before final install.
    b. BL01 – Bollard at Board Walk: minimum of (1) fixture to be reviewed. Final locations in plan to be verified before final install.
    c. FP01 – Flood light: minimum of (1) fixtures to be reviewed with final architectural panels. Final locations in plan to be verified before final install.
    d. FP01A – Flood light: minimum of (1) fixtures to be reviewed with final architectural panels. Architect and Lighting designer to confirm before final install.
    e. FLS02 – Flood light: minimum of (1) fixtures to be reviewed with final architectural panels. Architect and Lighting designer to confirm before final install.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

B. Package aluminum poles for shipping according to ASTM B 660.

C. Store luminaires in a dry, ventilated environment.

D. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

E. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.8 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

B. Mark locations of exterior luminaires for approval by Landscape Architect and Architect prior to the start of luminaire installation.

1.9 WARRANTY

When warranties longer than one year are required and would exceed the "one-year period for correction of work," verify with Owner's counsel that warranties stated in this article are not less than remedies available to Owner under prevailing local laws.

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures, including luminaire support components.
b. Faulty operation of luminaires, power supplies and accessories.
c. Deterioration of wood, metals, wood finishes, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: 5 year (s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

Product characteristics in this article apply to all luminaires in the Project.

A. Exterior lighting products are as specified in the lighting schedules and cut sheets or to be an approved equal. Lighting schedules and cut sheets are provided in the project manual and lighting sheets.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.

D. UL Compliance: Comply with UL 1598 and listed for wet location.

E. L70 lamp life of 50,000 hours.

F. Lamp Rating: Lamp marked for outdoor use.

G. Source Limitations: For luminaires, obtain each luminaire type designation from single source with resources to provide products of consistent quality in appearance and physical properties.

2.2 LUMINAIRE TYPES

A. Pole Mounted Site Lighting:

1. We-ef: Subject to compliance with requirements, provide products by manufacturers as indicated on fixture schedule and cut sheets, including luminaires and mounting equipment.

2. BK Lighting: Subject to compliance with requirements, provide products by manufacturers as indicated on fixture schedule and cut sheets, including luminaires and mounting equipment.

B. Architecturally Mounted Lighting:

1. Luminis: Subject to compliance with requirements, provide products by manufacturers as indicated on fixture schedule and cut sheets, including luminaires and mounting equipment.

C. Bollard Lighting:

1. Erco: Subject to compliance with requirements, provide products by manufacturers as indicated on fixture schedule and cut sheets, including luminaires and mounting equipment.

2. Cole Lighting: Subject to compliance with requirements, provide products by manufacturers as indicated on fixture schedule and cut sheets, including luminaires and mounting equipment.

D. Ingrade Lighting:

1. We-ef Lighting: Subject to compliance with requirements, provide products by manufacturers as indicated on fixture schedule and cut sheets, including luminaires and mounting equipment.

2.3 MATERIALS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Sheet Metal Components: Stainless steel. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.

D. Diffusers and Globes:

1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
2. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

E. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

F. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

G. Housings:

1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
2. Provide filter/breather for enclosed luminaires.

H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

a. "USE ONLY" and include specific lamp type.
b. Lamp diameter, shape, size, wattage and coating.
c. CCT and CRI for all luminaires.

2.4 FINISHES

A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

a. Finish and color: As selected by Architect from manufacturer's full range.

D. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds

and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.

2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

    a. Color: As selected by Architect from manufacturer's full range.

2.5 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Structural Characteristics: Comply with AASHTO LTS-4-M.

1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Structural Performance: The light poles and connections to the foundation shall withstand the gravity and lateral loads in accordance with AASHTO. Refer to Structural Analysis Criteria for Pole Selection section for design criteria.

C. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

D. UL Listing: Comply with NCBCC (2020 SCO Electrical Guidelines). Lighting poles more than 12 feet in height shall have an NCBCC approved third-party listing. Lighting poles less than or equal to 12 feet are listed with the luminaire.

E. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Shall not cause galvanic action at contact points. Provide separation as required.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
3. Anchor-Bolt Template: Plywood or steel.

F. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws.

G. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

2.6 ALUMINUM POLES

A. Poles: Seamless, extruded structural tube complying with ASTM B 429/B 429M, Alloy 6063-T6 with access handhole in pole wall.
   1. Finish: As selected by Architect from manufacturer's full range.

B. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

C. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 16 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

D. Brackets for Luminaires: As per required for proper installation of luminaire to pole.

   1. Finish: Same as pole.

E. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

   1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

      a. Color: As selected by Architect from manufacturer's full range.

2.7 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); one-piece construction up to 40 feet (12 m) in height with access handhole in pole wall.

   1. Shape: As per schedule.
   2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

B. Brackets for Luminaires: Detachable, cantilever, without underbrace.

   1. Adapter fitting welded to pole, allowing the bracket to be bolted to the pole mounted adapter, then bolted together with stainless-steel bolts.
   2. Cross Section: Section to accommodate luminaire.
   3. Match pole material and finish.

C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

D. Intermediate Handhole and Cable Support: Weathertight, 3-by-5-inch (76-by-127-mm) handhole located at midpoint of pole with cover for access to internal welded attachment lug for electric cable support grip.

E. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

F. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.

G. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

H. Galvanized Finish: After fabrication, hot-dip galvanize complying with ASTM A 123/A 123M.

I. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."
2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-build polyurethane enamel.

a. Color: As selected by Architect from manufacturer's full range

J. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.

B. Install lamps in each luminaire.

C. Fasten luminaire to structural support.

D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Support luminaires without causing deflection of finished surface.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

E. Wiring Method: Install cables in raceways. Conceal raceways and cables.

F. Install luminaires level, plumb, and square with finished grade unless otherwise indicated. Install luminaires at height and aiming angle as indicated on Drawings.

G. Coordinate layout and installation of luminaires with other construction.

H. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

I. Comply with requirements in Section "Low-Voltage Electrical Power Conductors and Cables" and Section "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.3 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for directional alignment of luminaires and their mounting provisions on the pole as indicated on drawings.

B. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 033000 "Cast-in-Place Concrete."

C. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
1. Grout void between pole base and foundation. Use non-shrink or expanding concrete grout firmly packed to fill space.
2. Install base covers unless otherwise indicated.
3. Use a short piece of 1/2-inch diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

D. Raise and set poles using clean web fabric slings (not chain or cable).

3.4 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 16 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 16 "Identification for Electrical Systems."

3.6 GROUNDING

A. Ground metal poles and support structures according to Division 16 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole unless otherwise indicated.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground nonmetallic poles and support structures according to Division 16 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole.
2. Install grounding conductor and conductor protector.
3. Ground metallic components of pole accessories and foundations.

3.7 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Verify operation of photoelectric controls.

2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

C. Luminaire will be considered defective if it does not pass tests and inspections.

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.8 AIMING AND ADJUSTING

Verify with Owner that adjusting service is required for Project.

A. Occupancy Adjustments: When requested prior to of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to 1 visit to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness and require adequate lift equipment and personnel for the aiming of tall poles. Protect finished surfaces from lifts or other equipment required in the aiming of fixtures.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect and lighting designer.

END OF SECTION

Company Logo

Company Name
Address
Email Contact Info

Project:

FUNCTIONAL PERFORMANCE TEST

LIGHTING CONTROLS – OCCUPANCY SENSORS

Tested By: _____

Date: _____

Notes:

1. Provide Yes/No confirmation of each parameter.
2. Provide single confirmation for all sensors in each control group.
3. Provide comments below where needed to further describe observations.

Control Parameter	**Specified Rating or Option Setting**	**Room Number or Control Group**																		
Activation Mode	Automatic																			
Time Delay	30 minutes																			
Walk Through	Off																			
PIR Sensitivity	90%																			
Ultrasonic Sensitivity	70%																			
Test Mode	Off																			
Detection Technology	PIR & US																			
Retrigger Technology	PIR or US																			
Response to HVAC operation	Unaffected																			
Response to sensor settings	As specified																			

Comments:

1.
2.
3.
4.

Company Logo

Company Name
Address
Email Contact Info

Project:

FUNCTIONAL PERFORMANCE TEST

LIGHTING CONTROLS – PHOTOCONTROL SWITCH

Tested By: _____

Date: _____

Notes:

1. Provide Yes/No confirmation of each parameter.
2. Provide comments below where needed to further describe observations.

Control Parameter	**Specified Rating or Option Setting**	**Equipment Name**	**Equipment Name**	**Equipment Name**	**Equipment Name**
Responsive to exterior ambient lighting conditions	On at dusk, off at dawn				
Response to artificial lighting	Unaffected				
Timed Override	2 Hours				
Specified lighting controlled	As shown on plans				

Comments:

1.
2.
3.
4.

Company Logo

Company Name
Address
Email Contact Info

Project:

FUNCTIONAL PERFORMANCE TEST

LIGHTING CONTROLS – RELAY PANEL

Tested By: _____

Date: _____

Notes:

1. Provide Yes/No confirmation of each parameter.
2. Provide comments below where needed to further describe observations.

Control Parameter	**Specified Rating or Option Setting**	**Equipment Name**	**Equipment Name**	**Equipment Name**	**Equipment Name**	**Equipment Name**
Accurate time and date observed						
Battery Installed/Operational						
Battery Runtime	72 Hours					
Timed Override	2 Hours					
Control Inputs	BAS/Time Clock/Photocontrol					
Control Input Mapping	As shown on plans					
Specified lighting controlled by Circuit #1	As shown on plans					
Specified lighting controlled by Circuit #2	As shown on plans					
Specified lighting controlled by Circuit #x	As shown on plans					

Comments:

1.
2.
3.
4.

SECTION 272000 – TELEPHONE/DATA SYSTEMS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Manufacturers: Firms regularly engaged in manufacture of telecommunications systems, of types and ratings required in this Section, whose products are Listed and Labeled for the purpose intended. Subject to compliance with requirements provide telecommunications system products equivalent to one of the following:

Ortronics Products
Amp Products
Siemon Co.
Superior Essex
Optical Cable Co.
Corning Inc.

Codes and Standards:

Electrical Code Compliance: Comply with applicable state code requirements of the authority having jurisdiction and appropriate NEC articles as applicable to the indicated equipment.

NEMA Compliance: Comply with applicable requirements of the National Electrical Manufacturers Association standard NEMA WC 66-1999, Performance Standard for Category 6 and Category 7 100-Ohm Shielded and Unshielded Twisted Pair Cables.

TIA/EIA Compliance: Comply with applicable requirements of TIA/EIA 568-B standards, TIA/EIA 569-A and TIA/EIA-607.

BICSI Compliance: Comply with applicable requirements of BICSI Telecommunications Distribution Methods Manual (TDMM).

Testing Laboratory Compliance: Comply with applicable requirements of relevant UL standards. Provide equipment that is Listed and Labeled.

Special-Use Markings: Provide equipment, constructed for special use, with appropriate Listed marks that indicate suitability for special type of use or application indicated.

State STS-1000 Compliance: Data wiring associated with state projects shall meet all applicable criteria of the latest edition of “North Carolina State STS-1000 Telecommunications Guidelines”.

SUBMITTALS

Submittals shall be made in strict accordance with the requirements of Section 019913. Specific submittal requirements are defined in each section of this Division.

Shop drawings for the system shall be submitted in a single package and shall include:

Product Data: Submit manufacturer's technical product data including specifications and installation instructions, for each component of the system required. Include data substantiating that equipment and materials comply with requirements. Literature shall indicate the function of each item and shall be cross-referenced to the Block Diagram.

Block Diagram: Submit a Block Diagram of the system showing all components and all connections. The Block Diagram shall clearly indicate all items that are supplied under other sections of these Specifications. Block Diagram shall show typical outlets and cables to each type of outlet. Block Diagram shall show layout of distribution frame including type of enclosure each type and quantity of distribution equipment. (Patch panels, splitters, etc.) to each distribution frame.

Installer's Qualifications: Firm with a minimum of five years documented successful installation experience on projects utilizing cabling infrastructure work similar in scope, complexity and size, to that required for this project. The Installer shall be an experienced firm regularly engaged in the layout and the installation of cabling infrastructure systems. The Installer must be able to show evidence that he has successfully completed projects of similar size and scope in the last 12 months. The Installer shall be a manufacturer certified installer for the products installed under this Section. Installer, supervisors, and designers shall have a current valid certification card.

The Installer's Project manager shall be certified as a BICSI RCDD.

In addition to having manufacturer required certifications the Installer shall meet the following criteria: 15% of work force shall be BICSI certified "Technician" level or higher (RCDD).

BICSI registration for all Installers and technicians working on project must be in current and in good standing.

During the shop drawing process, provide copies of all manufacturer and BICSI certifications. Also provide a picture ID of the person who is certified by the manufacturers and by BICSI. Provide a typed summary list showing how the Installer has complied with the requirements of this specification and what certifications each individual has.

The Installer's Project Manager must have experience in this type of project and he/she shall be expected to provide technical support.

The Installer's Project Manager shall attend the monthly progress meetings held by the state and additional meetings as scheduled or required.

Installer employees will wear visible ID badges on the job site with current picture and company name at all times.

PART 2 - PRODUCTS

OUTLET JACKS

Outlet jacks shall be modular with snap-in modules capable of numerous jack module combinations including RJ45, Fiber ST and SC, Angled Connectors, Type F, RJ11 and RCA Connectors. All combinations shall be capable of fitting on a single gang cover plate. Outlet combinations as shown on the drawings shall be composed of jacks that serve cables meeting the requirements outlined in this Section.

CABLE

General: All Categories of cabling shall meet the TIA / EIA 568-B and 598 standard. Inside Plant fiber cable shall comply with ANSI / ICEA S-83-596. Outside Plant fiber cable shall comply with ANSI / ICEA S-87-640.

A. Copper horizontal (outlet) and riser (backbone) cable station shall be UL listed, TIA / EIA Unshielded Twisted Pair – 100 ohm Category 6 Data Grade with transmission characteristics specified to a minimum of 250 MHz. Cables shall be CMR (riser rated) for use on risers where enclosed in raceways. Cables shall be CMP (plenum rated) for risers installed through sleeves and for all horizontal cabling to outlets. Provide white cable for telephone and blue cable for data, one cable per jack.

Category 6

Frequency MHz	Attenuation dB/100m	Next dB/100m	ACR dB/100m	PS-NEXT dB/100m	PS-ACR dB/100m	Return Loss dB/100m	ELFEXT dB/100m	PS-ELFEXT dB/100m
1	2.0	74.3	72.3	72.3	70.3	20.0	67.8	64.8
4	3.8	65.3	61.5	63.3	59.5	23.0	55.8	52.8
10	6.0	59.3	53.3	57.3	51.3	25.0	47.8	44.8
16	7.6	56.2	48.6	54.2	46.6	25.0	43.7	40.7
20	8.5	54.8	46.3	52.8	44.3	25.0	41.8	38.8
25	9.5	53.3	43.8	51.3	41.8	24.3	39.8	36.8
31.25	10.7	51.9	41.2	49.9	39.2	23.6	37.9	34.9
62.5	15.4	47.4	32.0	45.4	30.0	21.5	31.9	28.9
100	19.8	44.3	24.5	42.3	22.5	20.1	27.8	24.8
200	29.0	39.8	10.8	37.8	8.8	18.0	21.8	18.8
250	32.8	38.3	5.5	36.3	3.5	17.3	19.8	16.8

Notes:

1. Values are specified or calculated, based upon TIA 568-B.2-1.
2. Attenuation values are maximum acceptable levels. All other values are minimum levels at indicated frequency.

B. Multimode fiber optic cables shall be 62.5/125 micron Class Ia Graded Index Multimode Optical Fiber. Cable shall be OFNR (riser rated) for use on risers where enclosed in metallic raceways and OFNP (plenum rated) otherwise. Service cables shall be Outside Plant or Indoor / Outdoor (I/O) NEC Rating. All fiber cable shall be FDDI Compliant.

Coating Diameter: 250 Microns Core Eccentricity: 7.5% maximum (1.5% typical)

Numerical aperture: .275 plus or minus .015

Attenuation: 3.5 dB/km @ 850 NM 1.50 dB/km @ 1300 NM

Bandwidth: 160 MHz at 850 NM 500 MHz @ 1300 NM

Fiber connectors: SC .75 dB maximum insertion loss

Cable bend radius: 10 times diameter

Provide number of fiber strands and cable configurations as outlined in riser diagram.

C. Single mode fiber optic cables shall be 8.3/125 micron Class IVa Dispersion-Unshifted Single-mode Optical Fiber. Cable shall be OFNR (riser rated) for use on risers where enclosed in metallic raceways and OFNP (plenum rated) otherwise. Service cables shall be Outside Plant or Indoor / Outdoor (I/O) NEC Rating. All fiber cable shall be FDDI Compliant.

Coating Diameter: 250 Microns (1.5% typical) Core Eccentricity: 7.5% maximum

Attenuation: 0.5 dB/km @ 1310 NM . 5 dB/km @ 1550 NM

Zero dispersion wavelength 1300 -1320 NM

Cable bend radius: 10 times diameter
Provide number of fiber strands and cable configurations as outlined in riser diagram.

D. Hybrid copper and fiber, pre-terminated cable assembly for use in delivery of PoE/PoE+ and data over long distances. Cable assembly shall include minimum of 18 gauge copper conductors (1,000 ft. for PoE/650 ft. for PoE+) and tight buffered fiber (OM3) for service to one device. Cable shall be suitable for use outside or below grade in raceway where required by arrangement specified on the Drawings. Provide power injection device with external 120 VAC power source at point of origin in telecom room. Conversion at the device shall be accomplished with mountable remote converter having LC fiber terminations and M8 standard connector for input and RJ45 output to device.

TERMINATION

Copper Patch Panels: Provide 24/48 port, rack mountable, modular to 110, Category 6 compliant patch panels. Panels to use TIA / EIA 568B wiring scheme.

Fiber Termination Panels: Provide a rack mountable, modular cabinet capable of terminating up to 24 type SC multimode fiber cables.

At termination points for copper distribution cable that exits the building, provide surge suppression protectors near to the exit/entrance point to the building. All protectors shall be grounded using AWG 12 (minimum) copper wire for single line or double line, AWG 10 for three through six lines, and AWG 6 for seven or more lines. This conductor shall be grounded in accordance with NEC 800.100. The primary protector shall be189B1 with AT&T 3C1SC equivalent protector units (solid state type).

ENCLOSURES

19” Racks – Provide 7’ tall, 19” supporting rack with black anodized aluminum cross members. Rack to be securely bolted to floor.

Wall Cabinets – Provide 30” x 24” x 20” wall mounted steel cabinet. Cabinet to be capable of accepting 19” rack mountable equipment. Cabinet to have hinged front and back for access to both sides of equipment.

Telephone Backboards – Provide telephone backboards sized and located as indicated on the drawings. Backboards to be composed of 3/4" thick fire retardant exterior grade plywood. Backboard to be painted white as noted on plans.

PART 3 – EXECUTION

GENERAL

Provide a copper grounding bus at the main distribution frame (MDF) and each intermediate distribution frame (IDF). Provide 1 #2 AWG minimum, copper ground wire between ground bus in each IDF and the MDF to the supplemental ground bus at the main electrical room. In steel frame buildings, route 1 #6 AWG minimum, copper ground wire between ground bus in each IDF and building steel. Ground conductor shall be sized larger where specified on the drawings.

Route all cables in raceway within walls and inaccessible ceiling spaces.

Use nylon bushings at top of conduit where stubbed in accessible ceiling spaces.

Support all cables using cable tray, or J type hooks where cable tray is not available.

Provide a sleeved physical channel (innerduct) for fiber optic cable. This is to be within a metallic conduit system, unless the innerduct is plenum rated. The innerduct shall contain a pull string, if no fiber is pulled at the time of the installation of the duct.

All conduit, cable tray and wireway where fiber optic cable is installed shall be sized to maintain the manufacturer's recommended bend radius of fiber optic cables. As a minimum, conduit shall be provided with long radius elbows.

All cables shall be terminated using appropriate termination equipment.

Copper riser (backbone) cables shall be punched down on wall mounted M66-50 blocks. Cross connects to patch panels at rack are provided by Owner.

Provide appropriate cable management devices in all distribution frames to insure a neat appearance. The use of cable ties is prohibited.

Provide appropriate wire spools and backboards for voice blocks and cross-connect wiring. Spools shall run entire length of block arrangement above and below.

No horizontal cable length shall exceed 250 feet from the patch panel at the MDF or IDF to the outlet.

UTP TESTING

Category 6: Cable runs shall be tested for conformance to Level III parameters as specified TIA / EIA 568 B.2 and TIA / EIA Telecommunications System Bulletin (TSB) 67.

Test all cable pairs for the following conditions:

1. Polarity
2. Reversal of pairs
3. Wire transpositions
4. Continuity
5. Opens
6. Shorts

Test twisted pair cabling for each of the following parameters:

1. Wire Map (continuity)
2. Insertion Loss
3. Length
4. NEXT loss, pair-to-pair, measured from local end
5. NEXT loss, pair-to-pair, measured from far end
6. NEXT loss, power sum, measured from local end
7. NEXT loss, power sum, measured from far end
8. ELFEXT, pair-to-pair
9. ELFEXT, power sum
10. Return loss, measured from local end
11. Return loss, measured from far end
12. Propagation delay
13. Delay skew
14. ACR
15. Power Sum (PSACR).

Document all test data and submit to the engineer for review and approval prior to final review. Provide a summary form at front of documentation that identifies each cable tested, test results (passed, failed) and cable distance. Documentation approved by the engineer will be submitted to the Owner at the time of acceptance.

FIBER OPTIC TESTING

Upon completion of the passive optical cable system, the system must be tested to ensure compliance with the design and link loss specifications. The tests include:

Power meter tests – For building risers, power meter tests are required.

End-to-End Attenuation Testing-completed on each fiber span at both operational wavelengths:

- 850/1310 nm multimode
- 1550 nm single mode

Testing in one direction is required. Link attenuation does not include any active devices or passive devices other than cable, connectors and splices (e.g., link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers. Test results should be retained for inclusion into the documentation package.

Connector loss readings of each completed connector should be recorded using an OTDR at 850 and 1310 nm in one direction.

Optical Time Domain Reflectometer (OTDR) Signature Traces of each terminated fiber should be recorded at 850 nm and 1310 nm for fiber continuity purposes. OTDR testing is mandatory for runs longer than 2 km.

A Final Report should be compiled which records system configuration, fiber labels, cable routes and “as built” details. Loss measurements with calibrated light source and power meter shall be included. OTDR traces shall also be included when requested in advance.

TELECOMMUNICATIONS LABELING

ANSI/TIA/EIA 606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings is incorporated by reference and is to be complied with.

Each pathway (conduit, tray, raceway, etc.) that conveys telecommunications media from space to space must be given a unique identifier and labeled at each end-point.

Each telecommunications space (equipment room, telecommunications closet, work area, entrance facility, manhole and handhole) must be uniquely identified and labeled. Provide phenolic labels on each distribution frame, cabinet, enclosure or rack.

Each cable must be uniquely identified and labeled at each end.

Each cable record must indicate the cable type by manufacturer and manufacturer's designation, and document every pair/conductor in the cable. Cable identifier must be linked to all pathways in which it runs.

Each outlet is to be labeled. Labels are to be printed or typed. Provide self-adhesive labels unless provision for labeling is integral to the outlet.

Each piece of termination hardware such as a patch panel or wiring block must be uniquely named and labeled. Use printed self-adhesive labels.

Termination position on cross-connect must be identified by type, the pair/conductor terminated and a user code.

Each work area is labeled with a unique identifying number. A consistent labeling and numbering scheme shall be used. The labeling shall be clearly legible **on** the outlet face and the termination end. The numbering plan should identify the source and destination of the cable for horizontal runs. A sample number plan is:

208A-A1/241B

Where 208 is the telecommunications closet room #:
"A" is the patch panel identification,
"A1" is the "A" Block and the first position,
"241" is the workstation room #,
and "B" is the work space of the user in room 241.

Horizontal cable shall be labeled at the workstation end and the cross-connect end. Backbone cables (whether riser or horizontal) shall have an identifying number that is labeled at each end. Labels shall be the same color on each end. Performance documentation must use the same labeling scheme.

CLOSEOUT

The Contractor shall provide the Owner with a report outlining all tests previously noted. The Contractor shall provide a block diagram identifying all distribution frames, cabinets, backboards and the size and number of cables and conduits between each, as well as an outline of each unique type of outlet and connecting cable.

Provide minimum of a 25-Year Cabling System Warranty from the system Manufacturer. This warranty shall guarantee end-to-end system performance, shall cover both components and cabling, and shall cover materials and labor. This type of warranty, available from various system manufacturers, requires that installers be approved by, and registered with the system manufacturer.

END OF SECTION 272000

SECTION 283110 - FIRE ALARM SYSTEM MODIFICATIONS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

SCOPE

This section of the specifications includes the furnishing, installation, and connection of new initiation devices, alarm appliances, and related items to an existing fire alarm system. The final product shall be a complete coordinated system ready for operation. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, auxiliary control devices, annunciators, power supplies, and wiring as shown on the Drawings and specified herein.

The design provided is based on the NC Department of Administration 2020 Fire Alarm Guidelines and Policies and includes the relevant criteria from that document.

QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacture of fire alarm systems of types, sizes, and electrical characteristics required, and whose products are Listed and Labeled. Products of firms that do not maintain factory authorized service organization and spare parts stock are not acceptable for use on this project.

Installer's Qualifications: Installer shall be a company specializing in performing the work of this section, with a minimum of 5 years documented experience installing fire detection and alarm systems similar in size and scope to this project. Installer shall be certified by the manufacturer to install, program and service the system. Installer shall directly provide the final connections between the equipment and the wiring system and the addressing of all system devices.

Installer shall directly provide the installation of all wiring and devices required in the system, or provide supervision over this work when provided by the electrical contractor. Installer shall not sub-contract any portion of the required work to a third party. All work shall be performed in accordance with the Installer's submitted and approve fire alarm shop drawings and calculations.

System programming shall be done only by a manufacturer, or by an authorized Installer. The Installer's technicians who perform this work shall be trained and individually certified by the manufacturer, for the model and series of equipment being installed. The technicians' training and certification must have occurred in the most recent 24 months. Qualifications of installer, including technician certifications, shall be provided with equipment submittal.

Installer shall be present on site for the 100% test, Designer's pre-final review and Owner inspections.

Codes and Standards:

NFPA Compliance: Comply with applicable requirements of NFPA-72, 2013 National Fire Alarm Code.

NEC Compliance: Comply with applicable requirements of NFPA-70, National Electrical Code (NEC) standards pertaining to fire alarm systems.

Testing Laboratory Compliance: Comply with provisions of UL safety standards pertaining to fire alarm systems. Provide products and components which are Listed and Labeled.

UL Compliance: Provide fire alarm notification appliances consistent with requirements in UL 1971, Signaling Devices for the Hearing Impaired, for determining device operating currents and device ratings.

NCBC Compliance: Fire Alarm notification appliances shall comply with NC Building Code and NC Accessibility Code criteria for intensity and placement.

FM Compliance: Provide fire alarm systems and accessories which are FM approved.

SUBMITTALS

Submittals shall be made in strict accordance with the requirements of Section 019913. Specific submittal requirements are defined in each section of this Division.

Product Data: Submit Manufacturer's technical product data, including specifications and installation instructions, for each type of fire alarm system equipment. Submit technical product data on the fire alarm service equipment. Submittals shall provide mA draw for each device submitted and UL listed minimum voltage required to operate. Panel submittal shall list voltage drop allowed for panel and for individual NAC circuits.

Shop Drawings: Submit shop drawings showing equipment, device identification numbers and locations, and connecting wiring of entire fire alarm system. Include wiring and riser diagrams. Wiring diagrams shall be based on the project floor plans, with devices and proposed conduit routing shown. Provide conductor composition for each conduit section. Provide distance and route for each NAC (Notification Appliance Circuit). Risers diagrams shall show consecutive connections for all devices with addresses and ratings. Copies of Project Construction Documents or details therefrom may not be a part of the shop drawing submittal. Shop drawings shall be prepared in an electronic format that is convertible to DXF files. The fire alarm contractor shall submit complete shop drawings to the engineer for review prior to installation.

Wiring and Cabling: Submit wire and cable for signal circuits and notification circuits.

Installation Instructions: Submit Manufacturer's detailed installation instruction for all duct mounted smoke detectors, flow switches, tamper switches, supervisory switches, and similar items which require mechanical installation.

Battery Calculations: Provide battery calculations used to size secondary power source. Calculations must be submitted prior to installation of equipment. Battery calculations shall utilize the UL 1971 RMS DC or full wave rectified (FWR) current values of notification appliances, as appropriate for the power supply used, provided by the product manufacturer. These values shall be highlighted in the submittal for each appliance used in the project. Identify notification appliance circuit (NAC) current draws and calculate voltage drops for each circuit in the submittal package. Identify EOL voltage for each proposed NAC, based on a source voltage of 20.4 volts. In no case shall the calculated EOL for any NAC be below the minimum listed operating voltage for the devices used.

Device List: Submit a listing for each addressable device that indicates the device address, function and location. This information shall be the basis for the device descriptions to be programmed into the system, contingent upon approval of Designer and Owner. Information shall be included in device identification that is observed at the FACP and FAAP. Device addresses shall exactly match the information provided on the shop drawings.

Maintenance Data: Submit maintenance data and parts lists for each type of fire alarm equipment installed, including furnished specialties and accessories. Include this data, product data, and shop drawings in maintenance manual.

Maintenance Contract: Submit a quote for a maintenance contract to provide all maintenance, test, and repair described below and/or in accordance with NFPA-72, "Guide for Testing Protection Signaling Systems". Include also a quote of unscheduled maintenance/repair, including hourly rates for technicians trained on this equipment, and response travel costs. Submittals that do not identify all post contract maintenance costs will not be accepted. Rates and costs shall be valid for the period of five (5) years after expiration of the guaranty. Maintenance and testing shall be on a semiannual basis or as required by the local AHJ. A preventive maintenance schedule shall be provided by the Contractor that shall describe the protocol for preventive maintenance. The schedule shall include:

1. Semiannual systematic examination, adjustment and cleaning of all detectors, manual fire alarm stations, control panels, power supplies, relays, water flow switches and all accessories of the fire alarm system.
2. Semiannual testing of each circuit in the fire alarm system.
3. Semiannual testing of each smoke detector in accordance with the requirements of NFPA 72, Chapter 7.

Certifications: Submit a certification from the major equipment manufacturer indicating that the proposed supervisor of installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include names and addresses, and telephone numbers in the certification.

PART 2 - PRODUCTS

ALARM APPLIANCES

Speakers shall be located as shown on the Drawings: shall operate with synchronized audible output and have the following specifications:

Voltage: Speakers shall operate on 24 VDC nominal.

Taps: Provide speakers for audible sound with taps at 1/4 watt, 1/2 watt, 1 watt. Speakers shall be tapped at 1 watt for design purposes. Speakers shall provide the ANSI S3.41 three-pulse temporal pattern audible evacuation signal, described in NFPA 72.

Mounting: Provide flush mounting devices suitable for mounting in a standard single gang device box unless otherwise indicated on the Drawings. Unless otherwise indicated on the Drawings, speakers shall be mounted at 6'-8" (2.05 M) Above Finished Floor (AFF) or 6" (15.3 Cm) Below Finished Ceiling (BFC), whichever is lower.

Strobe Lights shall be located as shown on the Drawings. Strobe lights indicated for use exterior to the building shall be mounted at the indicated elevation and listed for use in wet locations. Strobe lights shall operate with synchronized flash output and have the following specifications:

Voltage: Strobe lights shall operate on 24 VDC nominal.

Maximum pulse duration: 2/10ths of one second.

Mounting: Provide flush mounting devices suitable for mounting in a standard single gang device box unless otherwise indicated on the Drawings. Unless otherwise indicated on the Drawings, strobe lights shall be mounted with the lower edge of the visual element at 6'-8" (2.05 M) Above Finished Floor (AFF) or 6" (15.3 Cm) Below Finished Ceiling (BFC), whichever is lower.

Strobe intensity and flash rate: Must meet minimum requirements of UL 1971. Provide strobe lights with minimum intensity Candela (Cd) rating of 15 Cd, or greater if such is indicated adjacent to the device symbol on the Drawings.

Audible/Visual Combination Devices shall be located as shown on the Drawings and shall comply with all applicable requirements for both Audible Device and Strobe Lights. Unless otherwise indicated on the Drawings, combination A/V devices shall be mounted with the lower edge of the visual element at 6'-8" (2.05 M) Above Finished Floor (AFF) or 6" (15.3 Cm) Below Finished Ceiling (BFC), whichever is lower.

Bells shall be 10" diameter vibrating type located as shown on the Drawings; bells located outdoors shall be listed for use in wet locations. Bells shall have the following specifications:

Voltage: Bells shall operate on 24 VDC nominal.

Mounting: Provide flush mounting devices suitable for mounting in a standard single gang device box unless otherwise indicated on the Drawings. Bell mounting elevation shall be as described on the Drawings.

INITIATING DEVICES

Addressable Devices - General: Unless otherwise indicated on the Drawings all initiating devices shall be individually addressable. Addressable devices shall comply with the following requirements:

Address Setting: Addressable devices shall provide an address-setting means that use rotary decimal switches configured to provide decade (numbered 1 to 10) type addresses. Devices which use a binary address setting method, such as a dip switch, are not acceptable.

Connections: Addressable devices shall be connected to a Signaling Line Circuit (SLC) with two (2) wires. Signaling Line Circuits shall originate as indicated on the Riser Diagram shown in the Drawings.

Operational Indications: Addressable initiation devices shall provide dual alarm and power LEDs. Both LEDs shall flash under normal conditions, indicating that the device is operational and in regular communication with the control panel. Both LEDs shall be placed into steady illumination by the FACP to indicate that an alarm condition has been detected. The flashing mode operation of the detector LEDs shall be optional through the system field program. An output connection shall also be provided in the device base to connect an external remote alarm LED.

Intelligent Initiation Devices: All smoke detectors shall be the "intelligent" in that smoke detector sensitivity shall be set through the FACP and shall be adjustable in the field through the field programming of the system. Sensitivity shall be capable of being automatically adjusted by the FACP on a time-of-day basis. Using software in the FACP, detectors shall be capable of automatically compensating for dust accumulation and other slow environmental changes that may affect performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.

Device mounting Base: Unless otherwise specified all detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature.

Sounder Base: Where indicated on the Drawings, provide bases with a built-in (local) sounder rated at 85 dBA minimum. Configure sounder bases such that sounders are activated under conditions as described or otherwise indicated on the Drawings.

Test Means: The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel when in the "test" condition.

Device Identification: Detectors shall store an internal identifying type code that the control panel shall use to identify the type of device. Device identifications shall be either ION, PHOTO, or THERMAL.

Addressable Pull Stations - General: Addressable pull stations shall, on command from the Control Panel, send data to the panel representing the state of the manual switch. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key. Pull stations that employ a glass break rod are not acceptable.

All pull stations shall be dual-action, have a positive, visual indication of operation and utilize a key type reset.

Construction: Pull stations shall be constructed of Lexan or other material suitable to the installation environment with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches or larger. Stations shall be suitable for surface mounting or semiflush mounting as shown on the plans. Unless otherwise indicated on the Drawings pull stations shall be mounted at 42" Above Finished Floor.

Photoelectric Smoke Detectors: Photoelectric smoke detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density. Unless otherwise indicated on the Drawings all smoke detectors shall be photoelectric type.

Ionization Smoke Detector: Ionization smoke detectors shall use the dual-chamber ionization principal to measure products of combustion and shall, on command from the control panel, send data to the panel representing the analog level of products of combustion. Ionization type smoke detectors are indicated on the Drawings by the designation ION adjacent to the smoke detector symbol.

Thermal Detectors: Thermal Detectors shall be intelligent addressable devices rated at 135°F. (58° C.) and unless otherwise indicated on the Drawings shall have a rate-of-rise element rated at 15° F. (9.4° C.) per minute. It shall connect via two wires to the Fire Alarm Control Panel Signaling Line Circuit. Up to 99 intelligent heat detectors may connect to one SLC loop. Thermal detectors shall use an electronic sensor to measure thermal conditions caused by a fire and shall, on command from the control panel, send data to the panel representing the analog level of such thermal measurements.

Non-Rate of Rise Detectors: Where indicated on the Drawings provide thermal detectors with non-rate of rise thermal elements. Non-rate of rise detectors are indicated by NRR adjacent to the thermal detector symbol.

Specialized Element Temperature Ratings: Where indicated on the Drawings provide thermal detectors with specialized element temperature ratings. Specialized element temperatures are indicated by a temperature rating adjacent to the thermal detector symbol, *e.g.* 195°F.

Multi-sensor Detectors: Mult-isensor detectors shall employ two or more of the above detection types with integrated operating principals, mounted in a single housing. Detectors shall combine photoelectric smoke detection, ionization smoke detection, and rate of rise thermal detection. The outputs of the analog sensors shall be transformed into digital signals that are combined and processed by special algorithms. The computations shall be designed to discriminate between normal ambient changes in a building and those changes associated with a fire.

Duct Smoke Detector: In-Duct Smoke Detector Housings shall accommodate either an intelligent ionization sensor or an intelligent photoelectric sensor as described elsewhere. The device, independent of the type used, shall be velocity rated and provide continuous analog monitoring and alarm verification from the panel. When sufficient smoke is sensed, an alarm signal shall be initiated at the FACP.

Installation: Duct detectors and related items shall be furnished and connected by the Division 28 (Electrical) Contractor but installed by the Division 20-25 (Mechanical) Contractor.

LINEAR BEAM SMOKE DETECTORS

Linear Beam Smoke Detectors shall be located as shown on the Drawings and shall be configured as an integral part of the Fire Alarm system. Linear beam smoke detectors shall meet the following requirements:

Linear beam detectors shall have a minimum of three calibrated sensitivity settings capable of maintaining sensitivity between 1.0% and 2.0% per meter obscuration, at any operating distance between 10 and 60 meters.

The manufacturer of linear beam detector shall provide a calibration chart giving the Smoke Sensitivity *versus* Operating Distance for each sensitivity setting. This chart shall show the UL permitted sensitivity limits for the entire range of rated operating distances.

Linear beam detectors must be rated for continuous operation up to 122°F (50°C) and a 95% relative humidity.

Compensating circuits must be provided in the detector to maintain normal sensitivity as environment conditions change and as dust builds up on the lenses. When the limits of this compensation are reached, a "trouble" signal must be initiated.
Horizontal and vertical adjustments must be provided, on both the transmitter and the receiver, for alignment of the IR beam. They must permit a minimum angular change of 7.5° from the center axis, in any direction.

The IR beam must be modulated, to assure reliable operation in the presence of very high ambient light and/or background IR.

Abrupt, maintained blockage of the IR beam shall result in a "trouble" signal (not alarm), to be initiated within a time span of 10 seconds minimum to 60 seconds maximum. Obscuration equal to the alarm threshold shall cause alarm within 10 seconds maximum.

Removal of the receiving unit's cover shall cause a "trouble" signal, to prevent tampering.

Linear beam type smoke detectors shall be supplied with a set of obscuration filters for convenient test, and a remote test switch installed at 5'-0" AFF. Remote test switches shall be located as shown on the Drawings.

MISCELLANEOUS SYSTEM ITEMS

Addressable Dry Contact Monitor Module: Addressable Monitor Modules shall be provided to connect one supervised IDC zone (either Style D or Style B) of non-addressable Alarm Initiating Devices (any Normally Open [N.O.] dry contact device) to one of the Fire Alarm Control Panel Signaling Line Circuit Loops. Monitor modules shall be installed as required by the system configuration. All required monitor modules may not be shown on the Drawings. Modules must be located in conditioned spaces unless they are tested, listed and marked for continuous duty across the range of temperature and humidity levels expected at their installed location.

Indication of Operation: Module shall include an LED that shall flash under normal conditions, indicating that the Monitor Module is operational and in regular communication with the control panel.

Mounting Requirements: Monitor Modules shall mount in a standard 4-inch square, 2-1/8" deep electrical box. LED shall be clearly visible through light pipe in box cover.
Supervision: Unless specifically noted otherwise on the drawings provide one monitor module for each sprinkler switch (tamper and flow) and one for each non-addressable detector.

Two Wire Detector Monitor Module: Addressable Monitor Modules shall be provided to connect one supervised IDC zone, either Class A or B (Style D or Style B operation) of non-addressable 2- wire smoke detectors or alarm initiating devices (any N.O. dry contact device) to one of the Fire Alarm Control Panel Signaling Line Circuit Loops. Monitor modules shall be installed as required by the system configuration and be UL Listed to operate with the specific smoke detectors in the IDC zone. All required monitor modules may not be shown on the Drawings. Modules must be located in conditioned spaces unless they are tested, listed and marked for continuous duty across the range of temperature and humidity levels expected at their installed location.

Indication of Operation: Module shall include an LED that shall flash under normal conditions, indicating that the Monitor Module is operational and in regular communication with the control panel.

Mounting Requirements: Monitor Modules shall mount in a standard 4-inch square, 2-1/8" deep electrical box. LED shall be clearly visible through light pipe in box cover.

Addressable Control Module: Addressable Control Modules shall be provided to supervise and control the operation of one conventional Notification Appliance Circuit (NAC) of compatible, 24 VDC powered, polarized Audio/Visual (A/V) Notification Appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contract relay. The control module shall provide address-setting means using decimal switches and shall also store an internal identifying code that the control panel shall use to identify the type of device. An LED shall be provided that shall flash under normal conditions, indicating that the control module is operational and is in regular communication with the control panel. Modules must be located in conditioned spaces unless they are tested, listed and marked for continuous duty across the range of temperature and humidity levels expected at their installed location.

Indication of Operation: Module shall include an LED that shall flash under normal conditions, indicating that the Control Module is operational and in regular communication with the control panel.

Mounting Requirements: Control Modules shall mount in a standard 4-inch square, 2-1/8" deep electrical box. LED shall be clearly visible through light pipe in box cover.

Configuration: The control module NAC circuit may be wired for Style Z or Style Y (Class A/B) with up to 1 Amp of inductive A/V signal, or 2 Amps of resistive A/V signal operation, or as a dry contact (Form C) relay. The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.

Power Source: Audio/visual power shall be provided by a separate supervised power loop from the main fire alarm control panel or from a supervised, UL listed remote power supply. A/V power sources and connections are not shown on the Drawings.

Test Switch: A magnetic test switch shall be provided to test the module without opening or shorting its NAC wiring.

Isolator Module: Isolator Modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC loop. The Isolator Module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC Loop. Modules must be readily accessible (not above ceiling) and clearly labeled. Modules must be located in conditioned spaces unless they are tested, listed and marked for continuous duty across the range of temperature and humidity levels expected at their installed location. Modules shall be shown on shop drawings and as-built drawings.

Indication of Operation: Module shall include an LED that shall flash under normal conditions, indicating that the Isolator Module is operational and in regular communication with the control panel. The LED shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

Operation: Isolator Modules shall operate such that if a wire-to-wire short occurs, the Isolator module shall automatically open-circuit (disconnect) the SLC loop. When the short circuit condition is corrected, the Isolator Module shall automatically reconnect the isolated section. The Isolator Module shall not require any address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an Isolator Module after its normal operation.

Mounting: The Isolator Module shall mount in a standard 4-inch square, 2-1/8" deep electrical box. LED shall be clearly visible through light pipe in box cover.

Water Flow Switch: Flow switches shall be integral, mechanical, non-coded, non-accumulative retard type. Flow switches shall have an alarm transmission delay time that is conveniently adjustable from 0 to 60 seconds. Initial settings shall be 30-45 seconds. Flow switches shall be located a minimum of one (1) foot from a fitting that changes the direction of the flow and a minimum of three (3) feet from a valve.

Location: Locations shown on the Drawings for water flow switches are approximate. Coordinate exact location with the sprinkler system installer.

Installation: Water Flow Switches shall be furnished and installed by the Division 28 (Electrical) Contractor.

Sprinkler and Standpipe Valve Supervisory Switch: Supervisory switch mechanisms shall be contained in a weatherproof aluminum housings that shall provide a 3/4 inch tapped conduit entrance and shall incorporate the necessary facilities for attachment to the valves. Switch housing shall be finished in red baked enamel.

Installation: Mount switch so as not to interfere with the normal operation of the valve and adjust to operate within two revolutions toward the closed position of the valve control, or when the stem has moved no more than one-fifth of the distance from its normal position. The entire installed assembly shall be tamper resistant and shall be arranged to cause a switch operation if the housing cover is removed or if the unit is removed from its mounting.

Installation: Supervisory switches shall be furnished and installed by the Division 28 (Electrical) Contractor.

Serially Connected LED Annunciator: Annunciator shall communicate with the fire alarm control panel *via* an EIA-485 communications loop (four-wire) and shall individually annunciate all zones in the system. System zones shall be as indicated on the Drawings. Up to 10 annunciators may be connected to the EIA-485 communications loop.

Annunciator Indicators: The annunciator shall provide a red Alarm LED per zone, and a yellow Trouble LED per zone. The annunciator shall also have an "ON-LINE" LED, local piezo sounder, local acknowledge/lamp test switch, and custom zone/function identification labels. Annunciator switches may be used for System control such as, Global Acknowledge, Global Signal Silence, and Global System Reset. All annunciator switches and indicators shall be software programmable.

LCD Alphanumeric Display Annunciator: The Alphanumeric display annunciator shall be a supervised, remotely located back-lit LCD display containing a minimum of eighty (80) characters for alarm annunciation in clear English text. The LCD annunciator shall display all alarm and trouble conditions in the system.

System Capacity: The system shall allow a minimum of four LCD annunciators. In addition to annunciation functions, each LCD annunciator shall be capable of the following software programmed system functions: Acknowledge, Signal Silence and Reset.

Connections: The annunciator shall connect to a two-wire EIA-485 interface. The two-wire connection shall be capable operation at distances of 6,000 feet. Provide interface to fiber optic cable systems and/or repeater units where such are indicated on the Drawings.

Remote Annunciator Indicator Lights (RAIL): Remote annunciator indicator lights shall be provided in locations where indicated on the Drawings. RAILs shall be provided with a key type switch for testing of the annunciated device. In addition, RAILs shall have the following features:

Voltage: RAILs shall operate on 24 VDC nominal.

Mounting: Provide flush mounting devices suitable for mounting in a standard single gang device box unless otherwise indicated on the Drawings. Unless otherwise indicated on the Drawings, RAILs shall be mounted as described for electronic sounders above.

Door Hold-Open Magnets: Door hold open magnets shall be suitable for mounting in a single gang electrical device box. Door hold open magnets shall be furnished with keepers, door chains, and other accessories as required to properly hold open doors as indicated on the Drawings. Holding force of the magnet shall be appropriate for the door to be held open. Proper attachment of door magnet hardware to doors is the responsibility of the Division 28 contractor. Door hold open magnets shall operate in a fail safe manner, *i.e.*, the door shall release in event of a failure of voltage to the device.

Power Source: Door hold open magnets shall be configured to operate from a nominal 24 VDC system as supplied by the FACP or other power supply listed for the purpose. All hold open magnet supply sources, whether a part of the FACP or whether derived from a separate power supply, shall be supervised. Door hold open magnet circuits which use step-down transformers, 120 VAC, or local relays are not permitted.

Device box support: Door hold open magnet device boxes shall be securely attached to the building structure by means of wood blocking or other equally effective means. Boxes attached directly to only one metal stud or boxes supported by means of expansion type fasteners are not acceptable.

Remote Power Supply: Ancillary power supply used to power NAC circuits, sounder bases, door holds and similar items shall operate on 120 VAC, 60 Hz and shall have a continuous rating adequate to power all equipment and functions in full alarm continuously. All modules and drivers must be able to withstand prolonged short circuits in the field wiring, either line-to-line or line-to-ground, without damage. The power supply shall provide a battery charger using dual-rate charging techniques for fast battery recharge. The remote power supply shall be monitored by the FACP. It shall not be installed above a ceiling or in a non-conditioned space.

Batteries: Shall be completely maintenance free, shall not require liquids, fluid level checks or refilling, and shall not be capable of producing spills and/or leaks. Batteries shall be sealed gel-cell type with expected life of 10 years. Battery voltage shall be as required by the power supply ad related equipment. Battery shall have sufficient capacity to power the fire alarm system for not less than 24 hours plus 5 minutes of alarm upon a normal AC power failure. The connected load for NAC circuits shall not exceed 75% of rated current output of the power supply.

PART 3 - EXECUTION

Fire and smoke detection and alarm systems shall comply with the following system requirements with regard to operation and installation.

All equipment and components shall be installed in strict compliance with manufacturers' recommendations. All equipment supplied must be specifically listed for its intended use and shall be installed in accordance with any instructions including in its listing. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation. Refer to the Riser/Connection diagram for all specific system installation/termination/wiring data.

All system components shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (*e.g.*, detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load. Adhesives are not permitted to mount fire alarm system components to building surfaces or structure.

The system shall be new and furnished with a warranty (parts & labor) of at least one year from the date of final inspection and acceptance by the Owner. Equipment, initiating devices, and alarm appliances shall be arranged as described in the Drawings; annunciator zones shall be configured as described in the Drawings.

The system shall be equipped with the following protective devices to prevent damage or nuisance alarms by nearby lightning strikes, stray currents, or voltage transients. The devices are to be provided by the fire alarm equipment supplier:

On AC Input: Provide a 120 volt, 20 amp feed through branch circuit series connected surge protective device (SPD) in dedicated enclosure. Install at panelboard and trim excess lead lengths. Wind small coil in branch circuit phase conductor, within SPD enclosure, downstream of the SPD connection. Coil is to be about 1" diameter, 5 to 10 turns, and tie-wrapped. Ditek DTK-120SRD series is a product meeting this performance specification. Equivalent unit with UL 1449 listing by other supplier are acceptable.

On DC Circuits Extending Outside Building: Near the point of entry to or exit from each building, provide a hybrid technology surge protection device on each leg. The filter shall consist of gas discharge tube (GDT) technology paired with silicon avalanche diode (SAD) technology, clamping voltage between 30 and 40 Volts. Ditek DTK – 2MHLPB series is a product meeting this performance specification. Equivalent unit with UL 497B listing by other supplier are acceptable. Devices shall not use only MOV active elements for protection.

Both audible and visible alarm signals shall be provided. Visible signals must be the strobe (flash discharge) type, with white or clear lens, and shall comply with current ADA requirements for intensity and placement.

If the system includes AHU shutdown or smoke removal startup, silencing the alarm (without resetting) must not reverse the shutdown. A supervised "AHU Shutdown Defeat" switch must be provided in the FACP. The switch must be labeled and its "Normal" position indicated. Provide supervised Hand-Off-Auto switch(es) at the FACP for any building smoke control equipment (pressurization or exhaust fans). The switch must cause a system “trouble” indication when it is placed in the off-normal (“shutdown defeated”) position.

The coverage of each fire alarm zone as described in the Drawings shall be indicated on the FACP and any remote annunciator. This may be accomplished by engraved labels, framed directories, and/or graphic displays. Label tape or handwritten labels are not acceptable.

Systems are to be provided with a separate and independent source of emergency power. Switching to emergency power during alarm shall not cause signal drop-out. Batteries must meet the appropriate NFPA capacity requirements, with a 25% safety factor. This requirement is in effect even if generator power is supplied to the Fire Alarm Control Panel.

Style 6 Circuits Required: Systems with one or more addressable sub-panels that (1) have an integral addressable loop controller, or (2) monitor multiple non-addressable initiation zones, shall comply with the NFPA 72 requirements for Style 6 circuits.

All wiring shall be color coded in accordance with the following scheme, which shall be maintained throughout the system, without color change in any wire run:

Signal Line Circuit cable	Red jacket with Red(+)/Black(-)
Alarm Indicating Appliance Circuits	Blue (+)/Black (-)
AHU Shutdown Circuits	Yellow (+)/Brown (-)
Initiation Circuits from Monitor Modules	Violet (+)/Gray (-)
Door Control Circuits	Orange
Elevator Capture Circuits	Brown

There shall be NO splices in the system other than at terminals in panels, fire alarm terminal cabinets (FATC) and devices. "Wire nuts," crimp splices, or insulation piercing type connectors are not acceptable. All terminal blocks shall be mounted in enclosures. All terminal screws shall have pressure wire connectors of the self-lifting or box lug type.

Permanent wire markers shall be used to identify all splices and terminations for each circuit. For splices within FATC’s, use markers or other means to indicate which conductors leads to the FACP.

In multistory buildings, all circuits leaving the riser on each floor shall feed through a labeled terminal block in an FATC with hinged cover, located for convenient access as indicated on the drawings. All required splices shall be made on termination blocks that are securely mounted in the cabinet. Wire markers and corresponding wiring legend shall be arranged as indicated on FATC detail on Drawings.

All fire alarm system cables and conductors shall be installed in raceway, couplers, and connectors meeting the performance of installation requirements of Section 260534, RACEWAYS. The minimum size for fire alarm system raceway shall be 3/4" trade size.

The exterior of all junction boxes containing fire alarm conductors shall be painted red; box interiors shall not be painted. Box covers for junction boxes containing fire alarm conductors shall be painted red on both sides. All painting of junction boxes and junction box covers shall be accomplished prior to installation of the boxes to avoid possible problems with overspray. Those boxes in finished areas are permitted to be painted to match the finish color.

Box covers shall be labeled to indicate the circuit(s) or function of the conductors contained therein. Labels shall be neatly applied black lettering on a clear background. Handwritten labels or labels made from embossed tape are not acceptable.

Raceways that penetrate outside walls from conditioned space shall have an internal seal to prevent condensation within the raceway as it enters the conditioned space.

Provide metal backboxes or plastic skirts as manufactured by the fire alarm manufacturer for devices installed in a surface mounted application. Such boxes shall match device in size and color.

Wire shall be new AWG #12 minimum stranded copper, type THHN/THWN for Notification Appliance Circuits. Addressable loop (signaling line) circuits shall be wired with type FPL/FPLR/FPLP fire alarm cable, AWG 18 minimum, low capacitance, twisted shielded copper pair. Cable shield drain wires are to be connected at each device on the loop to maintain continuity, taped to insulate from ground, and terminated at the FACP. Acceptable cables include Atlas 22-18-1-1STP, BSCC S1802s19 (same as EEC 7806LC), West Penn D975, D991 (AWG 16), D995 (AWG 14), or equal wire having capacitance of 30pf/ft maximum between conductors. The cable jacket color shall be red, with red (+) and black (-) conductor insulation.
EXCEPTION #1: Unshielded cable, otherwise equal to the above, is permitted to be used where the manufacturer's installation instructions unequivocally require, or state a preference for, the use of unshielded cable for all systems, AWG #16 minimum.

EXCEPTION #2: In underground conduit, use Type TC or PLTC cable (PE insulated) to avoid problems from moisture.

Detection or alarm circuits must not be included in raceways containing AC power or AC control wiring. Within the FACP, any 120 VAC control wiring or other circuits with an externally supplied AC/DC voltage above the nominal 24 VDC system power must be properly separated from other circuits and the enclosure must have an appropriate warning label to alert service personnel to the potential hazard.

Provide an engraved label in FACP identifying its 120 VAC power source. This label shall include panelboard location, identification, and circuit number.

Branch circuit breakers serving fire alarm systems shall be physically protected from inadvertent contact using a breaker handle lock. Load designation shall be clearly identified (typed) in the panel directory. Breakers shall be further identified with a permanent red dot applied to the handle or other visible portion of the breaker. Do not cover operable portions of the breaker or written information on the case in meeting this requirement.

All wiring shall be checked for grounds, opens, and shorts, prior to termination at panels and installation of detector heads. The minimum resistance to ground or between any two conductors shall be ten megohms (10 MW), as verified with a megger. Provide advance notice to the A-E of these tests.

All connections at the FACP must be made by the Manufacturer's authorized, factory trained representative (rather than by the electrical contractor).

The system shall be electrically supervised for open or (+/-) ground fault conditions in SLC, alarm circuits, and control circuits. Removal of any detection device, alarm appliance, plug-in relay, system module, or standby battery connection shall also result in a trouble signal. Fire alarm signal shall override trouble signals, but any pre-alarm trouble signal shall reappear when the panel is reset.

Sprinkler system supervisory circuits for monitoring valve position, air pressure, water temperature, pump status, etc., must cause distinct audible and visible indications at the FACP. The audible supervisory signal shall either be a 4" diameter bell or a pulsing piezo-electric alarm. Provide the following engraved label adjacent to the bell/alarm: "SPRINKLER STATUS ABNORMAL". If only valve position is supervised, provide an engraved label reading: "SPRINKLER VALVE CLOSED".

Spare Parts: Provide the following spare parts with the system, each individually packaged and labeled. For multi-building projects, calculate separately for each building:

Fuses	2 of each size used in the system
Manual Stations	2% of installed quantity
Addressble Control Modules	4% of installed quantity
Indoor Horns/Strobes	4% of installed quantity
Indoor Strobe-only Notification Appliances	4% of installed quantity
Monitor Modules (Addressable interface)	4% of installed quantity
Isolation Modules /Isolation Bases	4% of installed quantity
Addressable Heat Detectors, Bases	4% of installed quantity
Spot Smoke Detectors, Bases	6% of installed quantity

Increase decimal quantities of spare parts to the next higher whole number. For example, if a system has 20 spot-type smoke detectors provide 2 spare detectors with bases.

ALARM VERIFICATION FOR SMOKE DETECTORS

Fire alarm systems with automatic drift compensation functions shall be programmed with this feature activated for all spot-type detectors. Fire alarm systems equipped with alarm verification, shall not be programmed with the feature activated unless it is determined necessary through system testing.

Alarm verification shall be by device, with timer and tally. The system shall provide a timer function that can be set for a specific detector or input module.

The timer function shall delay alarm signal for a field-programmable time period. The control panel shall override the alarm verification functions if a subsequent alarm is reported during the verification period.

The talley function shall be capable of monitoring the total quantity of verification cycles initiated at the panel. A maximum verification count may be set in the field, ranging from 0-20. When the counter threshold is exceeded, a trouble signal shall be generated to the FACP.

Alarms from other than spot type smoke detectors must not be delayed by Alarm Verification. Alarm Verification is NOT to be applied to duct smoke detectors, nor to any software configured "cross-zoned" detection devices.

REMOTE ALARM TRANSMISSION REQUIREMENTS

Each system with automatic fire detection, or which monitors a sprinkler system shall be equipped with a NFPA 72 type, dual line, four channel minimum, Digital Alarm Communicator Transmitter (DACT) for transmission of its fire alarm, supervisory, and trouble signals to a Listed central station. As a minimum, where applicable, the following signals shall be transmitted.

Fire alarm
Sprinkler waterflow alarm
Fire pump running alarm (if pump provided)
Fire pump abnormal status supervisory signal
Sprinkler valve tamper (closed) supervisory signal
Sprinkler low temperature / Air pressure supervisory signal
Burglary / Intrusion / Duress / Other security or emergency alarms
Fire alarm system AC power trouble (only if 120 VAC is interrupted for 8 hours)

The precedence of DACT / Proprietary alarm system transmission shall be as follows:

1. Fire
2. Security
3. Supervisory
4. Trouble

The "trouble" signal must not be sent unless maintained for 60 seconds or more to avoid nuisance transmissions due to alarm verification cycles. Do not report ac power fail unless outage exceeds 8 hours.

With AHJ permission, Sprinkler and fire pump supervisory signals are permitted to be combined by the DACT, for transmission.

Provide a DACT which is compatible with the Owner's alarm receiving equipment or the Listed central station as indicated on the Drawings. Provide programming of any electronic memories (PROM "burn-in") and connect each DACT to the appropriate telephone or communications lines. Verify proper signal receipt of each channel by the supervising station.

Where leased or dedicated lines are available back to the Owner's security station and where indicated on the Drawings, provide a polarity reversal type alarm module. Note that polarity reversal type alarm modules report only Alarm, Line Trouble, and OK conditions.

SMOKE DETECTORS

Detectors must be the plug-in type, each having a separate base, not a mounting ring, to facilitate replacement and maintenance. The base shall have integral terminal strips for circuit connections, rather than wire pigtails. Each detector or detector base shall incorporate an LED to indicate alarm. When installed in a room, detectors shall be oriented so their alarm light is visible from the nearest door to the corridor, unless Remote Alarm Indicator Light (RAIL) equipped.

A smoke detector shall be mounted with in 15 feet horizontally of each piece of fire alarm control system equipment, including transponders, sub-panels, and booster power supplies.

Spot type smoke detectors mounted within 12 feet of a walking surface shall have their built-in locking device activated. Activate the locks after the system has passed the final inspection by the owner.

Spot type smoke detectors shall not be used where ceiling height exceeds 25 feet, due to the increased difficulty with access for maintenance and the impact on device performance.

Activate automatic drift compensation feature for all spot type smoke detectors. Systems shall not have alarm verification feature activated with drift compensation functions activated.

Set spot-type smoke detector sensitivity to normal/ medium, unless directed otherwise by the design engineer or owner’s representative. Make additional changes as directed during testing and certification of the system.

Unless suitably protected against dust, paint, etc., detectors shall not be installed until the final construction clean-up has been completed. Covers supplied with smoke detectors do not provide adequate protection from heavy construction activities and shall not be used in this manner. Contaminated detectors must be REPLACED by the Contractor at no additional cost to the Owner.

Identification of individual detectors is required. These device numbers, which must also be shown on the shop drawings, shall be permanently affixed to the detector base. Device labels may not be affixed to the device. Identification labels must be printed labels with black lettering on a clear background. Handwritten labels or labels made from embossed tape are not acceptable.

Where shown on the Drawings air duct/plenum detectors must have a RAIL with a keyed Alarm Test switch, located in the nearest corridor or public area and identified by an engraved label affixed to the wall or ceiling.

Smoke detector guards, where indicated on the Drawings shall be Listed for use with the specific model of smoke detector being protected. All smoke detector guards are to have a separate base which must be very securely anchored to wall or ceiling. The cover must be readily removable by the Owner for periodic detector cleaning and servicing but, to prevent unauthorized entry, must be secured to the base by a lock or tamper resistant screws approved by the A-E. Metal guards must be 16 gauge or heavier steel.

LINEAR BEAM SMOKE DETECTORS

Linear beam type smoke detectors shall be installed in locations as shown on the Drawings.

AUTOMATIC SMOKE DOOR AND AUTOMATIC LOCK REQUIREMENTS

Wall-mounted magnetic door holders and separate heavy-duty closers shall be used, instead of combination door control units. The electromagnets shall be controlled by the building's smoke detection system FACP. Individual smoke detector auxiliary contacts shall not be used to release door holders.

Automatic door locks controlled by the system must be either fail safe magnetic locks or fail-safe electro-mechanical with reverse bevel dead bolts.

All lock protected doors must immediately unlock upon fire alarm, loss of AC power, disablement of the fire alarm system (defined as loss of 24 VDC power) or upon manual operation of an unlock switch at a constantly attended location.

Where door locks are installed on smoke or fire rated doors, power failure shall cause these mechanisms to default to egress mode (automatically close) with normal mechanical latching.

Smoke doors are permitted to be held open by magnets powered by the FACP or remote power supplies and released upon alarm. The resulting current drain must be accounted for in the stand-by current for the appropriate battery calculation or the system shall be programmed to drop the door magnets within 60 seconds after a loss of primary (120 VAC) power.

SPRINKLER SYSTEM MONITORING

The following sprinkler system alarm and supervisory functions shall be provided as a part of the fire alarm system:

1. Waterflow alarm, by sprinkler zone (not to exceed one floor).
2. Supervision of each control valve.
3. Supervision of air pressure, if used (both high and low).
4. Supervision of fire pump.

Sprinkler supervisory monitoring of flow switches, tamper switches, and similar functions shall be accomplished with a separate system address for each activity monitored.

KITCHEN EXHAUST HOOD EXTINGUISHING SYSTEMS

Installation shall comply with the current edition of NFPA Standard for the type of system installed.

System(s) shall be interconnected with the fire alarm system as a separate system address.

The following operational requirements are generally provided directly by the extinguishing system. The Contractor shall verify that the means for providing the following operation sequence is in place:

The exhaust fan must continue running after the system has been discharged, (except on carbon dioxide systems) to remove smoke; the supply fan should stop. All sources of heat for appliances served by the extinguishing system (both electric and/or gas) must be turned off.

The fire alarm system shall monitor the control power to shunt trip breakers used to interrupt power to kitchen equipment.

ELEVATOR SHUTDOWN SYSTEMS

Installation shall comply with the current editions of NFPA 72 and ANSIASME A17.1.

System(s) shall be interconnected with the fire alarm system such that the following components occur at each installed sprinkler head in the elevator machine room and elevator hoistway, including the pit.

A smoke detector placed adjacent the sprinkler head shall monitor for early indication of smoke. Upon alarm, the appropriate sequence of elevator recall is initiated, based on the location of the smoke detector.

A heat detector placed adjacent the sprinkler head shall monitor for early indication of heat. Upon alarm, the branch breaker(s) serving the elevator car(s) shall be shunt trip to de-energize power to each elevator controller.

The fire alarm system shall monitor the control power circuit to shunt trip breakers used to interrupt power to elevator controllers.

FIRE ALARM SYSTEM INSTALLATION AND CONFIGURATION

In addition to other requirements of these Specifications the fire alarm system must comply with the following:

The addressable fire alarm system shall be connected, programmed, and tested only by the Manufacturer or by an authorized distributor who stocks a full compliment of spare parts for the system. Technicians performing this service shall be trained and individually certified by the Manufacturer for the model of system being installed. Copies of installer certification must be included with the Contractor's submittal.

The complete configuration data (site-specific programming) for the system must be permanently stored on a USB drive or compact disc (CD) and archived by the manufacturer or authorized distributor. A USB drive or compact disc (CD) copy of this data must be submitted to the A-E for transmission to the Owner when the system is commissioned.

The Manufacturer or authorized distributor must maintain software version (VER) records on the system installed. The system software shall be upgraded free of charge if a new VER is released for any reason during the warranty period. For any new VER to correct problems, free upgrade shall apply during the entire life of the system.

All addressable loop controller circuits (SLCs) must be NFPA 72 Style 6 ("Class A") and shall have a minimum of 20% spare addresses for future use. "T-taps" from the loop are not permitted. To minimize the impact of a wiring fault on the system, isolation modules must be provided as follows:

1. At the FACP, at each end of the loop.
2. At the mid-point of a loop with less than 20 devices or control points.
3. After each 20 devices/control points on any addressable circuit.
4. For each circuit extending outside the building.
5. At each terminal cabinet on loops serving multiple floors (each floor).

Notification Appliance Circuits (NACs) shall be NFPA 72 Style Y (Class B). The load connected to each circuit must not exceed 80% of rated supply output. The coverage of each circuit shall not exceed 3 floors. The NAC voltage drop during alarm shall not exceed 14% of the voltage measured across the batteries. The contractor shall use power outage testing to verify proper installation.

Supervision required: The connection between individual addressable modules and their contact type initiating device(s) must be supervised.

The Fire Alarm System shall have multiple access levels which permit the Owner's authorized personnel to disable individual alarm inputs or normal system responses (outputs) for alarms without changing the system's executive programming or affecting operation of the rest of the system. This must include the ability to override selected alarm inputs or system responses to alarms without affecting the remaining portions of the system. The owner shall be taught how to make these changes in the training program provided.

The fire alarm system shall have a self-contained modem with a minimum speed of 9,600 baud for external communications purposes. All system functions and programming features must be available through the modem port. The modem port shall be password protected with multiple access levels as described above. Telephone lines and connections to the modem will be furnished and installed by the Owner.

Where indicated on the Drawings, a Graphic Annunciator (GA) with separate Light Emitting Diodes (LED) indication for each alarm and supervisory signal initiating device shall be included. Multiple initiating devices of the same type within a single room may be permitted to share a common LED. The GA must show all major building features such as corridors, elevators, stairs, exits, and "YOU ARE HERE". GA layout must be submitted for approval.

Graphic Chart must be mounted behind Plexiglass and secured to surface. Mounting shall be such that charts cannot be removed without a flat head screw driver.

Floor Plans with Device Numbers: A copy of the floor plans shall be provided in the control panel. A separate sheet shall be provided for each floor. Plans shall be reduced in size from engineering plans in order to fit on 11 x 14 sheets. All device addresses shall be clearly labeled on plans. Indicate locations of all cabinets, modules and end of line resistors. Plans shall be bound in book form. Sheets shall be laminated. Provide legend for symbols. Provide holder for plan book in panel or in a locked box adjacent to panel keyed to match panel. Provide label for box and book.

Loop 1 shall be assigned to the first floor devices and loop number shall increase with floor number. Device numbering starts in the same location on each floor and increase accordingly as circuit location increases.

In addition to the system tests and certification described elsewhere, the Manufacturer or authorized distributor must 100% test all site-specific software functions for the system and provide a written test report or detailed check list.

SYSTEM DOCUMENTATION

The contractor shall provide the A-E with three copies of the following:

1. As-built wiring and conduit layout diagrams, including wire color code and/or label numbers, and showing all interconnections in the system.
2. Electronic circuit diagrams of all control panels, modules, annunciators, communications panels, etc.
3. Technical literature on all major parts of the system, including control panels, batteries, detectors, manual stations, alarm indicating appliances, power supplies, and remote alarm transmission means.
4. Detailed maintenance requirements as recommended by the fire alarm manufacturer.

The contractor shall provide the A-E with one copy of the following:

1. All software required, both for the installed fire alarm system and for any personal computer (PC) necessary to access the fire alarm system for trouble shooting, programming, modifications, monitoring, de-bugging, or similar functions.
2. Complete documentation for all software for both the installed fire alarm system and for any interface PC software necessary for system functions as described in (1) above.

3. Framed floor plans for installation at the FACP. Plans shall show all system devices with the unique device identification numbers indicated adjacent to each device. The identification numbers shall match those represented in the as-built drawings and those reported at the FACP and the LCD annunciator.

SYSTEM TESTING & CERTIFICATION

Upon completion of the installation the Division 28 Contractor and the Manufacturer's authorized installer together shall conduct a 100% performance test of each alarm initiating device that is added and/or modified as part of the construction activity for proper response. In addition, a 10% test as defined in NFPA 72 shall be conducted for system devices and circuits in the building that were not directly impacted by the specified work. The system shall operate for 48 hours prior to start of test. The Division 28 Contractor shall be present for the full 100% test.

The Contractor's 100% Performance test shall consist of the following. Upon activation of each alarm initiating device, verify effective operation of every alarm notification appliance and all other functions such as elevator capture, control smoke doors/dampers, proper operations of HVAC systems, and pressurization fans. In addition, verify proper annunciation of each activated device, including device identification number, type and location, at the FACP and each remote annunciator. The FACP shall reset after testing of each alarm initiating device. The digital communicator shall be on-line and tested for proper communication to the receiving station. Equivalent methods of demonstrating proper operation of HVAC shutdown are acceptable for this test. All supervised circuits must also be tested to verify proper supervision. (Control circuits and remote annunciation lines are among those required to be supervised.)

All testing described above shall be repeated in the event that subsequent software or wiring modifications are determined necessary to meet the requirements of the contract documents. Such re-testing shall be included as part of the base bid and provided at no additional cost to the Owner.

The A-E must be given 7 days advance notice of the tests.

The contractor must submit the following test documentation:

1. Written verification that this system test (100% and 10%) was done with copy of print out generated during test.
2. System status and programming report, including a system operation matrix showing the actual FACP response for each initiating device. In addition, provide the measured sensitivity of each smoke detector. (Generate on date of Designer Pre-Final).
3. NFPA 72-2013 "Record of Completion" form: Use this form to detail the system installation and to certify that it was installed per code requirements.
4. Voltage table indicating voltage at battery and at the last device on each NAC circuit. Take readings at the start of test and every 15 minutes during NAC test. Test shall be 30 minutes minimum.

After completion of the Contractor's 100% performance test and submission of the above documentation, the contractor will request in writing that the A-E set up a pre-final review.

If the initial inspection determines that the required 100% system test was not reasonably done, or if a reinspection of the project is requested without the punch list being nearly completed, the Contractor *may* be required to reimburse the Designer for inspection costs.

System Report: In addition to the shop drawing submittal the fire alarm system contractor shall provide the engineer two bound copies of the following technical information, for transmittal to the owner:

1) As-Built wiring diagram showing all loop numbers and device addresses, plus terminal numbers where they connect to control equipment.
2) Manufacturer's detailed maintenance requirements
3) Technical literature on all control equipment, isolation modules, power supplies, alarm/ supervisory signal initiating devices, alarm notification appliances, relays, etc…
4) The as-built "calculations" sheet referenced elsewhere in this specification.

Electronic archive: Complete configuration data (site-specific programming) for the system must be stored on electronic media and archived by the fire alarm system manufacturer or authorized distributor. A USB drive or compact disc (CD) copy of this data shall be submitted to the engineer for transmission to the owner.

INSPECTIONS

Fire Alarm System Designer Pre-final Review: Upon completing the fire alarm system installation, and prior to scheduling the Designer Pre-final review, the installation contractor must successfully conduct and complete a 100% performance test of the entire fully functional system. All audio visual device tests shall be scheduled with the owner.

As part of the Designer Pre-final review the system will be inspected and functionally tested on a comprehensive basis. Equipment intended for open area protection or releasing device service may be subjected to simulated or actual test fires in accordance with ANSI/UL guideline and sound engineering practice, to verify proper response.

The Contractor shall provide two-way radios, equipment keys, as-built drawings, ladders, smoke products, meter and other materials required to test the system. The test will be conducted entirely by the Contractor. Any deficiencies shall be recorded and corrected. After the items have been corrected, the system shall be tested again in the presence of the Engineer.

In the event of malfunctions or excessive nuisance alarms, the Contractor must take prompt corrective action. The Owner may require a repeat of the Contractor's 100% system test, or other inspections. Continued improper performance during the warranty period shall be cause to require the Contractor to remove and replace the system.

Test Report: Upon successful completion of the Performance Inspection and correction of all deficiencies, the manufacturer’s authorized representative shall issue a test report to the Engineer, detailing and certifying the test.

Final Inspection: At the Owner’s request and after passing the pre-final review, the Division 28 Contractor and Manufacturer’s authorized installer will conduct a full system test in the presence of the Owner and the Designer. Upon request, a copy of the final database software must be presented to the Owner on USB drive before this test. The software shall be loaded from the drive into the system in the presence of the Owner and Engineer. See requirements for pre-final test and conduct similarly.

System Acceptance: After successful completion of the Final Inspection and recommendation of the Engineer, the system will be accepted by the Owner. At this time the warranty period begins. In the event of malfunctions or excessive nuisance alarms, the Contractor must take prompt corrective action. The Owner may require a repeat of the Contractor's 100% system test, or other inspections. Continued improper performance during the warranty period shall be cause to require the Contractor to remove the system.

END OF SECTION 283110

SYSTEM RECORD OF COMPLETION

This form is to be completed by the system installation contractor at the time of system acceptance and approval.
It shall be permitted to modify this form as needed to provide a more complete and/or clear record.
Insert N/A in all unused lines.
Attach additional sheets, data, or calculations as necessary to provide a complete record.

Form Completion Date:_____ Supplemental Pages Attached:_____

1. PROPERTY INFORMATION

Name of property:_____
Address:_____
Description of property:_____
Name of property representative:_____
Address:_____
Phone:_____ Fax:_____ E-mail:_____

2. INSTALLATION, SERVICE, TESTING, AND MONITORING INFORMATION

Installation contractor:_____
Address:_____
Phone:_____ Fax:_____ E-mail:_____
Service organization:_____
Address:_____
Phone:_____ Fax:_____ E-mail:_____
Testing organization:_____
Address:_____
Phone:_____ Fax:_____ E-mail:_____
Effective date for test and inspection contract:_____
Monitoring organization:_____
Address:_____
Phone:_____ Fax:_____ E-mail:_____
Account number:_____ Phone line 1:_____ Phone line 2:_____
Means of transmission:_____
Entity to which alarms are retransmitted:_____ Phone:_____

3. DOCUMENTATION

On-site location of the required record documents and site-specific software:_____

4. DESCRIPTION OF SYSTEM OR SERVICE

This is a: ❑ New system ❑ Modification to existing system Permit number:_____
NFPA 72 edition:_____

4.1 Control Unit

Manufacturer:_____ Model number:_____

4.2 Software and Firmware

Firmware revision number:_____

4.3 Alarm Verification

❑ This system does not incorporate alarm verification.
Number of devices subject to alarm verification:_____ Alarm verification set for _____ seconds

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FIGURE 7.8.2(a) System Record of Completion. (SIG-FUN)

SYSTEM RECORD OF COMPLETION *(continued)*

5. SYSTEM POWER

5.1 Control Unit

5.1.1 Primary Power

Input voltage of control panel: _____ Control panel amps: _____

Overcurrent protection: Type: _____ Amps: _____

Branch circuit disconnecting means location: _____ Number: _____

5.1.2 Secondary Power

Type of secondary power: _____

Location, if remote from the plant: _____

Calculated capacity of secondary power to drive the system:

In standby mode (hours): _____ In alarm mode (minutes): _____

5.2 Control Unit

❑ This system does not have power extender panels

❑ Power extender panels are listed on supplementary sheet A

6. CIRCUITS AND PATHWAYS

Pathway Type	Dual Media Pathway	Separate Pathway	Class	Survivability Level
Signaling Line				
Device Power				
Initiating Device				
Notification Appliance				
Other (specify):				

7. REMOTE ANNUNCIATORS

Type	Location

8. INITIATING DEVICES

Type	Quantity	Addressable or Conventional	Alarm or Supervisory	Sensing Technology
Manual Pull Stations				
Smoke Detectors				
Duct Smoke Detectors				
Heat Detectors				
Gas Detectors				
Waterflow Switches				
Tamper Switches				

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FIGURE 7.8.2(a) *Continued*

SYSTEM RECORD OF COMPLETION *(continued)*

9. NOTIFICATION APPLIANCES

Type	Quantity	Description
Audible		
Visible		
Combination Audible and Visible		

10. SYSTEM CONTROL FUNCTIONS

Type	Quantity
Hold-Open Door Releasing Devices	
HVAC Shutdown	
Fire/Smoke Dampers	
Door Unlocking	
Elevator Recall	
Elevator Shunt Trip	

11. INTERCONNECTED SYSTEMS

❑ This system does not have interconnected systems.

❑ Interconnected systems are listed on supplementary sheet _____.

12. CERTIFICATION AND APPROVALS

12.1 System Installation Contractor

This system as specified herein has been installed according to all NFPA standards cited herein.

Signed: _____ Printed name: _____ Date: _____

Organization: _____ Title: _____ Phone: _____

12.2 System Operational Test

This system as specified herein has tested according to all NFPA standards cited herein.

Signed: _____ Printed name: _____ Date: _____

Organization: _____ Title: _____ Phone: _____

12.3 Acceptance Test

Date and time of acceptance test: _____

Installing contractor representative: _____

Testing contractor representative: _____

Property representative: _____

AHJ representative: _____

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FIGURE 7.8.2(a) *Continued*

EMERGENCY COMMUNICATIONS SYSTEMS SUPPLEMENTARY RECORD OF COMPLETION

This form is a supplement to the System Record of Completion. It includes systems and components specific to emergency communications systems.
This form is to be completed by the system installation contractor at the time of system acceptance and approval.
It shall be permitted to modify this form as needed to provide a more complete and/or clear record.
Insert N/A in all unused lines.

Form Completion Date:_____ Number of Supplemental Pages Attached:_____

1. PROPERTY INFORMATION

Name of property: _____

Address: _____

2. DESCRIPTION OF SYSTEM OR SERVICE

❑ Fire alarm with in-building fire emergency voice alarm communication system (EVAC)

❑ Mass notification system

❑ Combination system, with the following components:

❑ Fire alarm ❑ EVACS ❑ MNS ❑ Two-way, in-building, emergency communications system

❑ Other (specify): _____

NFPA 72 edition: _____ Additional description of system(s): _____

_____

2.1 In-Building Fire Emergency Voice Alarm Communications System

Manufacturer:_____ Model number: _____

Number of single voice alarm channels:_____ Number of multiple voice alarm channels: _____

Number of speakers: _____ Number of speaker circuits:_____

Location of amplification and sound processing equipment: _____

_____

_____

Location of paging microphone stations:

Location 1: _____

Location 2: _____

Location 3: _____

2.2 Mass Notification System

2.2.1 System Type:

❑ In-building MNS–combination

❑ In-building MNS ❑ Wide-area MNS ❑ Distributed recipient MNS

❑ Other (specify): _____

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FIGURE 7.8.2(b) Emergency Communications System Supplementary Record of Completion. (SIG-FUN)

EMERGENCY COMMUNICATIONS SYSTEMS
SUPPLEMENTARY RECORD OF COMPLETION *(continued)*

2. DESCRIPTION OF SYSTEM OR SERVICE *(continued)*

2.2.2 System Features:

❑ Combination fire alarm/MNS ❑ MNS autonomous control unit ❑ Wide-area MNS to regional national alerting interface
❑ Local operating console (LOC) ❑ Distributed-recipient MNS (DRMNS) ❑ Wide-area MNS to DRMNS interface
❑ Wide-area MNS to high power speaker array (HPSA) interface ❑ In-building MNS to wide-area MNS interface
❑ Other (specify): _____

2.2.3 MNS Local Operating Consoles

Location 1: _____
Location 2: _____
Location 3: _____

2.2.4 High Power Speaker Arrays

Number of HPSA speaker initiation zones: _____
Location 1: _____
Location 2: _____
Location 3: _____

2.2.5 Mass Notification Devices

Combination fire alarm/MNS visual devices: _____ MNS-only visual devices: _____
Textual signs: _____ Other (describe): _____
Supervision class: _____

2.2.6 Special Hazard Notification

❑ This system does not have special suppression predischarge notification.
❑ MNS systems DO NOT override notification appliances required to provide special suppression predischarge notification.

3. TWO-WAY EMERGENCY COMMUNICATIONS SYSTEMS

3.1 Telephone System

Number of telephone jacks installed: _____ Number of warden stations installed: _____
Number of telephone handsets stored on site: _____
Type of telephone system installed: ❑ Electrically powered ❑ Sound powered

3.2 Two-Way Radio Communications Enhancement System

Percentage of area covered by two-way radio service: Critical areas _____ % General building areas _____ %
Amplification component locations: _____

_____

Inbound signal strength _____ dBm Outbound signal strength _____ dBm
Donor antenna isolation is _____ dB above the signal booster gain.
Radio frequencies covered: _____
Radio system monitor panel location: _____

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FIGURE 7.8.2(b) *Continued*

EMERGENCY COMMUNICATIONS SYSTEMS SUPPLEMENTARY RECORD OF COMPLETION *(continued)*

3. TWO-WAY EMERGENCY COMMUNICATIONS SYSTEMS *(continued)*

3.3 Area of Refuge (Area of Rescue Assistance) Emergency Communications Systems

Number of stations: _____ Location of central control point: _____

Days and hours when central control point is attended: _____

Location of alternate control point: _____

Days and hours when alternate control point is attended: _____

3.4 Elevator Emergency Communications Systems

Number of elevators with stations: _____ Location of central control point: _____

Days and hours when central control point is attended: _____

Location of alternate control point: _____

Days and hours when alternate control point is attended: _____

3.5 Other Two-Way Communications System

Describe: _____

4. CONTROL FUNCTIONS

This system activates the following control functions specific to emergency communications systems:

Type	Quantity
Mass Notification Override of Alarm Signaling Systems or Appliances	

See Main System Record of Completion for additional information, certifications, and approvals.

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FIGURE 7.8.2(b) *Continued*

POWER SYSTEMS
SUPPLEMENTARY RECORD OF COMPLETION

This form is a supplement to the System Record of Completion. It includes systems and components specific to power systems that incorporate generators, UPS systems, remote battery systems, or other complex power systems. This form is to be completed by the system installation contractor at the time of system acceptance and approval. It shall be permitted to modify this form as needed to provide a more complete and/or clear record. Insert N/A in all unused lines.

Form Completion Date:_____ Number of Supplemental Pages Attached:_____

1. PROPERTY INFORMATION

Name of property: _____

Address: _____

2. SYSTEM POWER

2.1 Control Unit

2.1.1 Primary Power

Input voltage of control panel: _____ Control panel amps: _____

Overcurrent protection: Type: _____ Amps: _____

Location (of primary supply panelboard): _____

Disconnecting means location: _____

2.1.2 Engine-Driven Generator

Location of generator: _____

Location of fuel storage: _____ Type of fuel: _____

2.1.3 Uninterruptible Power System

Equipment powered by UPS system: _____

Location of UPS system: _____

Calculated capacity of UPS batteries to drive the system components connected to it:

In standby mode (hours): _____ In alarm mode (minutes): _____

2.1.4 Batteries

Location: _____ Type: _____ Nominal voltage: _____ Amp/hour rating: _____

Calculated capacity of batteries to drive the system:

In standby mode (hours): _____ In alarm mode (minutes): _____

2.2 In-Building Fire Emergency Voice Alarm Communications System or Mass Notification System

2.2.1 Primary Power

Input voltage of EVACS or MNS panel: _____ EVACS or MNS panel amps: _____

Overcurrent protection: Type: _____ Amps: _____

Location (of primary supply panelboard): _____

Disconnecting means location: _____

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FIGURE 7.8.2(c) Power Systems Supplementary Record of Completion. (SIG-FUN)

POWER SYSTEMS
SUPPLEMENTARY RECORD OF COMPLETION *(continued)*

2. SYSTEM POWER *(continued)*

2.2.2 Engine-Driven Generator

Location of generator: _____

Location of fuel storage: _____ Type of fuel: _____

2.2.3 Uninterruptible Power System

Equipment powered by UPS system: _____

Location of UPS system: _____

Calculated capacity of UPS batteries to drive the system components connected to it:

In standby mode (hours): _____ In alarm mode (minutes): _____

2.2.4 Batteries

Location: _____ Type: _____ Nominal voltage: _____ Amp/hour rating: _____

Calculated capacity of batteries to drive the system:

In standby mode (hours): _____ In alarm mode (minutes): _____

2.3 Notification Appliance Power Extender Panels

❑ This system does not have power extender panels.

2.3.1 Primary Power

Input voltage of power extender panel(s): _____ Power extender panel amps: _____

Overcurrent protection: Type: _____ Amps: _____

Location (of primary supply panelboard): _____

Disconnecting means location: _____

2.3.2 Engine Driven Generator

Location of generator: _____

Location of fuel storage: _____ Type of fuel: _____

2.3.3 Uninterruptible Power System

Equipment powered by UPS system: _____

Location of UPS system: _____

Calculated capacity of UPS batteries to drive the system components connected to it:

In standby mode (hours): _____ In alarm mode (minutes): _____

2.3.4 Batteries

Location: _____ Type: _____ Nominal voltage: _____ Amp/hour rating: _____

Calculated capacity of batteries to drive the system:

In standby mode (hours): _____ In alarm mode (minutes): _____

See Main System Record of Completion for additional information, certifications, and approvals.

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FIGURE 7.8.2(c) *Continued*

NOTIFICATION APPLIANCE POWER PANEL SUPPLEMENTARY RECORD OF COMPLETION

This form is a supplement to the System Record of Completion. It includes a list of types and locations of notification appliance power extender panels.
This form is to be completed by the system installation contractor at the time of system acceptance and approval.
It shall be permitted to modify this form as needed to provide a more complete and/or clear record.
Insert N/A in all unused lines.

Form Completion Date:_____ Number of Supplemental Pages Attached:_____

1. PROPERTY INFORMATION

Name of property: _____

Address: _____

2. NOTIFICATION APPLIANCE POWER EXTENDER PANELS

Make and Model	Location	Area Served	Power Source

See Main System Record of Completion for additional information, certifications, and approvals.

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FIGURE 7.8.2(d) Notification Appliance Power Panel Supplementary Record of Completion. (SIG-FUN)

INTERCONNECTED SYSTEMS SUPPLEMENTARY RECORD OF COMPLETION

This form is a supplement to the System Record of Completion. It includes a list of types and locations of systems that are interconnected to the main system.
This form is to be completed by the system installation contractor at the time of system acceptance and approval.
It shall be permitted to modify this form as needed to provide a more complete and/or clear record.
Insert N/A in all unused lines.

Form Completion Date:_____ Number of Supplemental Pages Attached:_____

1. PROPERTY INFORMATION

Name of property: _____

Address: _____

2. INTERCONNECTED SYSTEMS

Description	Location	Purpose

See Main System Record of Completion for additional information, certifications, and approvals.

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FIGURE 7.8.2(e) Interconnected Systems Supplementary Record of Completion. (SIG-FUN)

SECTION 311000 - SITE CLEARING

GENERAL

RELATED DOCUMENTS

a. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

SUMMARY

b. Section Includes:

1) Removing existing vegetation.
2) Clearing and grubbing.
3) Stripping and stockpiling topsoil.
4) Removing above- and below-grade site improvements.
5) Disconnecting, capping or sealing, removing site utilities, and abandoning site utilities in place.
1) Temporary erosion- and sedimentation-control measures.

b. Related Sections:

1) Division 01 Section "Temporary Facilities and Controls" for temporary utility services, construction and support facilities, security and protection facilities, and temporary erosion- and sedimentation-control measures.
2) Division 01 Section “Temporary Tree and Plant Protection”
3) Division 01 Section "Execution" for field engineering and surveying.
4) Division 01 Section(s) "Construction Waste Management and Disposal
5) Division 31 Section “Erosion and Sedimentation Control” for wind and stormwater sediment control pollution.

DEFINITIONS

a. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

b. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

a. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

a. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.

a. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and indicated on Drawings or defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated on plans.

b. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

MATERIAL OWNERSHIP

c. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

SUBMITTALS

a. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

QUALITY ASSURANCE

a. Preinstallation Conference: Conduct conference at Project Site, Raleigh NC.

b. Conduct preconstruction conference with City of Raleigh for work on Foundation property prior to work on-site.

PROJECT CONDITIONS

c. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

    1) Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
    2) Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

a. Utility Locator Service: Notify ULOCO for area where Project is located before site clearing.

a. Do not commence site clearing operations until temporary erosion- and sedimentation-control measures are in place and erosion control permit is obtained and posted at job-site.

a. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

PRODUCTS

MATERIALS

a. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Division 31 Section "Earth Moving."

   1) Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

EXECUTION

PREPARATION

a. Protect and maintain benchmarks and survey control points from disturbance during construction.

b. Install temporary construction fencing per Section 01 “Temporary Facilities and Controls” and per Section 32 “Chain Link Fencing”.

a. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated. Wrap a 1-inch blue vinyl tie tape flag around each tree trunk at 54 inches above the ground.

b. Protect existing site improvements to remain from damage during construction.

   1) Restore damaged improvements to their original condition, as acceptable to Owner.

TEMPORARY EROSION AND SEDIMENTATION CONTROL

a. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of the City of Raleigh and NCDENR.

a. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

b. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

c. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

EXISTING UTILITIES

a. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.

    1) Verify that utilities have been disconnected and capped before proceeding with site clearing.

b. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

    1) Coordinate with Owner prior to shutting off any utilities.
    2) Arrange with utility companies to shut off indicated utilities.

b. Locate, identify, and disconnect utilities indicated to be abandoned in place.

a. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

    1) Notify Owner, and Engineer not less than fourteen (14) days in advance of proposed utility interruptions.
    2) Do not proceed with utility interruptions without Engineer's written permission.

a. Excavate for and remove underground utilities indicated to be removed.

CLEARING AND GRUBBING

b. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

    1) Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
    2) Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches below exposed subgrade.
    3) Chip removed tree branches and dispose of off-site.

a. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

    1) Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

TOPSOIL STRIPPING

b. Remove sod and grass before stripping topsoil.

a. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.

1) Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

a. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1) Limit height of topsoil stockpiles to 72 inches.
2) Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
1) Stockpile surplus topsoil to allow for respreading deeper topsoil.

SITE IMPROVEMENTS

a. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

b. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1) Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement and concrete to remain before removing adjacent existing pavement or concrete. Saw-cut faces vertically.

DISPOSAL OF SURPLUS AND WASTE MATERIALS

c. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

a. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

PART 40 - END OF SECTION 311000

SECTION 312000 - EARTH MOVING

GENERAL

RELATED DOCUMENTS

a. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

b. North Carolina Department of Transportation and City of Raleigh Standard Specifications and Details where applicable.

SUMMARY

c. Section Includes:

1) Preparing subgrades for slabs-on-grade, walks, pavements, turf and grasses, and plants.
2) Excavating and backfilling for structures.
3) Subbase course for concrete walks and pavements.
4) Subbase course and base course for asphalt paving.
5) Subsurface drainage backfill for walls and trenches.
6) Excavating and backfilling trenches for utilities and pits for buried utility structures.

a. Related Sections:

1) Division 01 Section "Construction Progress Documentation” for recording pre-excavation and earth moving progress.
2) Division 01 Section "Temporary Facilities and Controls" for temporary controls, utilities, and support facilities; also for temporary site fencing if not in another Section.
1) Division 31 Section "Site Clearing" for site stripping, grubbing, stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
2) Division 31 Section “Erosion and Sedimentation Control”.

UNIT PRICES

a. Work of this Section is affected by unit prices and quantity allowances for earth moving specified in Division 01 Section "Unit Prices and Allowances."

b. Rock Measurement: Volume of rock actually removed, measured in original position, but not to exceed the following. Unit prices for rock excavation include replacement with approved materials for that condition.

1) 24 inches outside of concrete forms other than at footings.

2) 12 inches outside of concrete forms at footings.

3) 6 inches outside of minimum required dimensions of concrete cast against grade.

4) Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.

5) 6 inches beneath bottom of concrete slabs-on-grade.

6) 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

DEFINITIONS

a. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1) Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2) Final Backfill: Backfill placed over initial backfill to fill a trench.

b. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

c. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

d. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

a. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

b. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1) Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Engineer or Owner's Testing Agency. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
2) Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
3) Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Engineer or Owner's Testing Agency. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.

c. Fill: Soil materials used to raise existing grades.

a. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation or 3/4 cu. yd. for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

1) Excavation of Footings, Trenches, and Pits: Late-model Caterpillar D-8 (or equivalent) pulling a single-tooth ripper.
1) Bulk Excavation: Late-model, track-mounted Caterpillar 330 (or equivalent) using new rock teeth.

a. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

b. Reinforced Soil Fill: Soil materials specifically designed and compacted for use with Segmental Retaining walls designed by others.

c. Structural Fill: Soil fee of trash, refuse, frozen material, or other deleterious materials, and contains less than 3% organics.

d. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

e. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

f. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

SUBMITTALS

a. Product Data: For each type of the following manufactured products required:

1) Geotextiles.
2) Lightweight structural fill.
3) Detector warning tapes.

b. Samples for Verification: For the following products, in sizes indicated below:

1) Geotextile: 12 by 12 inches.
2) Warning Tape: 12 inches long; of each color.
3) Lightweight structural fill.

a. Qualification Data: For qualified testing agency.

a. Material Test Reports: For each on-site soil material proposed for fill and backfill as follows:

1) Classification according to ASTM D 2487.
2) Laboratory compaction curve according to ASTM D 698 or ASTM D 1557.

b. Blasting plan approved by authorities having jurisdiction.

c. Seismic survey report from seismic survey agency.

a. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

QUALITY ASSURANCE

b. Blasting: Comply with applicable requirements in NFPA 495, "Explosive Materials Code," and prepare a blasting plan reporting the following:

1) Types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
2) Seismographic monitoring during blasting operations.

c. Seismic Survey Agency: An independent testing agency, acceptable to authorities having jurisdiction, experienced in seismic surveys and blasting procedures to perform the following services:

1) Report types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
2) Seismographic monitoring during blasting operations.

a. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

a. Pre-excavation Conference: Conduct conference at the Project Site.

PROJECT CONDITIONS

b. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.

1) Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2) Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

a. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1) Do not proceed with work on adjoining property until directed by Owner.

a. Utility Locator Service: Notify “ULOCO” for area where Project is located before beginning earth moving operations.

b. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures, specified in Division 31 Sections "Site Clearing" and “Erosion and Sedimentation Control” are in place.

c. Do not commence earth moving operations until a City of Raleigh Permit is obtained and posted at the project site.

d. Do not commence earth moving operations until plant-protection measures specified in Division 01 Section "Temporary Tree and Plant Protection" are in place.

e. Do not commence underground storage tank removal until qualified person has coordinated and received permission for removal by NCDENR.

f. The following practices are prohibited within protection zones:

1) Storage of construction materials, debris, or excavated material.
2) Parking vehicles or equipment.
3) Foot traffic.
4) Erection of sheds or structures.
5) Impoundment of water.
6) Excavation or other digging unless otherwise indicated.
7) Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

b. Do not direct vehicle or equipment exhaust towards protection zones.

c. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PRODUCTS

SOIL MATERIALS

a. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

a. Satisfactory Soils: Soil Classification Groups SM, SC, SW, SP, ML, and CL according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter. CH and MH found at the project site can be used, provided the moisture content can be controlled, but should not be placed within the last 3-feet in building areas and within the last 2-feet in pavement areas.

1) Compacted to not less than 95% of the Standard Proctor maximum below 12” and not less than 100% of the Standard Proctor maximum for the last 12”.

b. Unsatisfactory (or Unsuitable) Soils: Soil Classification Groups OL and OH according to ASTM D 2487, or a combination of these groups.

1) Unsatisfactory soils also include satisfactory soils not maintained within 3 percent of optimum moisture content at time of compaction.

a. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

b. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

c. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

d. Structural Fill: Fill material shall not contain rocks greater than 3 inches in diameter or greater than 25% retained on the ¾ -inch sieve or more than 3% (by weight) of organic matter or other deleterious material. Fill should possess a Maximum Dry Density (MDD) of 95 pounds per cubic foot (pcf) or greater as determined by the Standard Proctor Compaction Test (ASTM D698).

e. Reinforced Soil Fill: ASTM D 2487; GW, GP, SW, SP, and SM soil classification groups or a combination of these groups; free of debris, waste, frozen materials, vegetation, and other deleterious matter; meeting the following gradation according to ASTM C 136: 20 to 100 percent passing No. 4 (4.75-mm) sieve, 0 to 60 percent passing No. 40 (0.425-mm) sieve, 0 to 35 percent passing No. 200 (0.075-mm) sieve, and with fine fraction having a plasticity index of less than 20.

f. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

g. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

h. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.

i. Sand: ASTM C 33; fine aggregate.

j. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

k. Lightweight Structural Fill: All lightweight fill systems shall meet the following requirements:

1) Lightweight fill shall meet ASTM C-578, VII
2) Minimum compressive strength, ASTM D-1621, 60 psi (414kPa)
3) Maximum water absorption by volume per ASTM C-272, 0.1%
4) Water vapor permeance of 1: product per ASTM E-96, 1.0 perm (max)
5) Product shall be free of CFC’s

GEOTEXTILES

a. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; complying with AASHTO M 288 and the following, measured per test methods referenced:

1) Grab Tensile Strength: 205 lb; ASTM D 4632.
2) Grab Tensile Elongation: 50%; ASTM D 4632.
3) Trapezoidal Tear Strength: 80 lb; ASTM D 4533.
4) CBR Puncture Strength: 500 lb; ASTM D 6241.
1) Apparent Opening Size: No. 80 sieve, maximum; ASTM D 4751.
1) Permittivity: 0.2 per second, minimum; ASTM D 4491.
1) UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

a. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
1) Grab Tensile Strength: 247 lbf; ASTM D 4632.
2) Sewn Seam Strength: 222 lbf; ASTM D 4632.
3) Tear Strength: 90 lbf; ASTM D 4533.
4) Puncture Strength: 90 lbf; ASTM D 4833.
1) Apparent Opening Size: No. 60 sieve, maximum; ASTM D 4751.
2) Permittivity: 0.02 per second, minimum; ASTM D 4491.
3) UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

ACCESSORIES

a. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:

1) Red: Electric.
2) Yellow: Gas, oil, steam, and dangerous materials.
3) Orange: Telephone and other communications.
4) Blue: Water systems.
5) Green: Sewer systems.

b. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:

1) Red: Electric.
2) Yellow: Gas, oil, steam, and dangerous materials.
3) Orange: Telephone and other communications.
4) Blue: Water systems.
5) Green: Sewer systems.

b. Detectable Tracer Wire: In accordance with NC General Statute 87-121 (g), the City of Raleigh requires a #12 solid bare copper wire is to be installed with gravity sewer mains and services, storm drainage systems, reuse mains and services, and any nonmetallic water service tubing. It is not required for DIP water mains or copper water services.

EXECUTION

PREPARATION

c. Follow Construction Sequence provided on Drawings.

d. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

e. Protect and maintain erosion and sedimentation controls during earth moving operations.

f. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

DEWATERING

g. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

h. Excavation for foundations to be kept free of standing water by use of pump(s) and silt bag(s) as required.

i. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

    1) Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

EXPLOSIVES

j. Explosives: Obtain written permission from authorities having jurisdiction before bringing explosives to Project site or using explosives on Project site.

    1) Perform blasting without damaging adjacent structures, property, or site improvements.
    2) Perform blasting without weakening the bearing capacity of rock subgrade and with the least-practicable disturbance to rock to remain

EXCAVATION, GENERAL

a. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation, removal of obstructions, or unsuitable soils to subgrade elevation.

1) If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory materials.
2) Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:

    a) 24 inches outside of concrete forms other than at footings.
    12 inches outside of concrete forms at footings.
    b) 6 inches outside of minimum required dimensions of concrete cast against grade.
    c) Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
    d) 6 inches beneath bottom of concrete slabs-on-grade subbase materials.
    e) 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

b. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Engineer. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.

    1) Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.

        a) Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

    2) Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:

        a) 24 inches outside of concrete forms other than at footings.
        b) 12 inches outside of concrete forms at footings.
        c) 6 inches outside of minimum required dimensions of concrete cast against grade.
        d) Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
        e) 6 inches beneath bottom of concrete slabs-on-grade.
        f) 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

c. Unsatisfactory Soils: Volume of unsatisfactory soils and/or unsuitable debris actually removed below the subgrade/bearing elevation, measured in original position, and replaced with satisfactory subgrade/foundation material that meets the allowable design bearing pressure, compaction requirements, and settlement limitations specified in the geotechnical report and construction documents for the site and structure. Changes in the Contract Sum or the Contract Time will be in accordance with Allowances and Unit Prices provisions for removal and replacement of unsuitable soils.

EXCAVATION FOR STRUCTURES

d. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1) Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
2) Deep Foundations: Stop excavations 6 to 12 inches (150 to 300 mm) above bottom of pile cap before deep foundations are placed. After foundations have been installed, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete caps.
3) Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch (25 mm). Do not disturb bottom of excavations intended as bearing surfaces.

e. Excavations at Edges of Tree- and Plant-Protection Zones:

1) Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2) Cut and protect roots according to requirements in Division 01 Section "Temporary Tree and Plant Protection."

EXCAVATION FOR WALKS AND PAVEMENTS

f. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

EXCAVATION FOR UTILITY TRENCHES

a. Excavate trenches to indicated gradients, lines, depths, and elevations.

1) Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

b. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit.

1) Clearance: 6 inches each side of pipe or conduit.

a. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1) For pipes and conduit less than 6 inches in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
2) For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
3) For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
4) Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

b. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation, removal of obstructions, or unsuitable soils to trench bottom.

c. Trenches in Tree- and Plant-Protection Zones:

1) Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2) Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
3) Cut and protect roots according to requirements in Division 01 Section "Temporary Tree and Plant Protection."

SUBGRADE INSPECTION

a. Notify Owner’s Testing Agency when excavations have reached required subgrade.

b. If Owner’s Testing Agency determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

a. Proof-roll subgrade below pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1) Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
2) Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Engineer or Owner’s Testing Agency, and replace with compacted backfill or fill as directed.

b. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation, removal of obstructions, or unsuitable soils to subgrade elevation.

c. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer, without additional compensation.

UNAUTHORIZED EXCAVATION

a. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2,500 psi, may be used when approved by Engineer.

1) Fill unauthorized excavations under other construction, pipe, or conduit as directed by Engineer.

STORAGE OF SOIL MATERIALS

b. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1) Stockpile soil materials away from edge of excavations.
2) Place silt fence approximately 3-ft from edge of stockpile.
3) Do not store within drip line of remaining trees.

BACKFILL

c. Place and compact backfill in excavations promptly, but not before completing the following:

1) Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2) Surveying locations of underground utilities for Record Documents.
3) Testing and inspecting underground utilities.
4) Removing concrete formwork.
5) Removing trash and debris.
6) Removing temporary shoring and bracing, and sheeting.
7) Installing permanent or temporary horizontal bracing on horizontally supported walls.

b. Place backfill on subgrades free of mud, frost, snow, or ice.

UTILITY TRENCH BACKFILL

c. Place backfill on subgrades free of mud, frost, snow, or ice.

d. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

a. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Division 03 Section “Cast-in-Place Concrete”

b. Trenches under Roadways: Provide 4-inch- thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely

encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Division 03 Section "Cast-in-Place Concrete."

c. Backfill voids with satisfactory soil while removing shoring and bracing.

a. Place and compact initial backfill of subbase material and satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.

1) Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

a. Place and compact final backfill of satisfactory soil to final subgrade elevation.

b. All underground piping and utilities (both metallic and non-metallic), except lawn irrigation lines, shall have two stages of identification and/or warning by a combination of non-detectable and detectable warning tapes.

a. Install warning tape (detectable warning tape) directly on top of the pipeline and permanently secured to the pipeline at 10’ intervals.

b. Install identification tape (non-detectable warning tape) approximately 18” to 30” above the service pipe, but a minimum of 10” and a maximum of 24” below finished grade.

c. Install tracer wire to bottom of pipe taped at a maximum of 10’ intervals. An insulated copper tracer wire or other approved conductor shall be installed along the length of the pipe to all nonmetallic piping, including irrigation lines, and metallic pipe with compression gasket fittings installed underground. Access shall be provided to the tracer wire or the tracer wire shall terminate aboveground at the end of the nonmetallic piping. The tracer wire size shall be copper single-conductor 10AWG minimum and the insulation type suitable for direct burial with type “UF” (Underground Feeder) insulation and shall be continuous along the pipeline passing through the inside of each valve box or manhole.

SOIL FILL

d. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

e. Place and compact fill material in layers to required elevations as follows:

1) Under grass and planted areas, use satisfactory soil material.
2) Under walks and pavements, use satisfactory soil material.
3) Under steps and ramps, use engineered fill.
4) Under building slabs, use engineered fill.
1) Under footings and foundations, use engineered fill.

b. Place soil fill on subgrades free of mud, frost, snow, or ice.

SOIL MOISTURE CONTROL

a. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 3 percent of optimum moisture content.

1) Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2) Fill materials shall not be classified as unsatisfactory if the fill materials' natural moistures are outside the required moisture range and otherwise meet the material requirements for satisfactory materials. The contractor shall dry these materials to the acceptable moisture range.
3) Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 3 percent and is too wet to compact to specified dry unit weight.

COMPACTION OF SOIL BACKFILLS AND FILLS

a. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

b. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

a. Compact soil materials to not less than the following percentages of maximum dry unit weight according to Standard Proctor:

1) Under structures, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 98 percent.
2) Under walkways, scarify and recompact top 12 inches below subgrade and compact each layer of backfill or fill soil material at 98 percent.
3) Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.
4) For utility trenches, compact each layer of initial and final backfill soil material at 98 percent.

GRADING

b. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1) Provide a smooth transition between adjacent existing grades and new grades.
2) Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

c. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1) Turf or Unpaved Areas: Plus or minus 1 inch.

2) Walks: Plus or minus 1 inch.
3) Pavements: Plus or minus 1/2 inch.

b. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot (3-m) straightedge.

SUBSURFACE DRAINAGE

a. Subdrainage Pipe: Specified in Division 33 Section "Subdrainage."

a. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches.

1) Compact each filter material layer to 95 percent of maximum dry unit weight according to ASTM D 698 with a minimum of two passes of a plate-type vibratory compactor.

a. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.

1) Compact each filter material layer to 95 percent of maximum dry unit weight according to ASTM D 698 with a minimum of two passes of a plate-type vibratory compactor.
1) Place and compact impervious fill over drainage backfill in 6-inch- thick compacted layers to final subgrade.

SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

a. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.

b. On prepared subgrade, place subbase course and base course under pavements and walks as follows:

1) Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2) Place base course material over subbase course under hot-mix asphalt pavement.
1) Shape subbase course and base course to required crown elevations and cross-slope grades.
2) Place subbase course and base course 6 inches or less in compacted thickness in a single layer.
3) Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
4) Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 98 percent of maximum dry unit weight according to ASTM D 698.

a. Pavement Shoulders: Place shoulders along edges of subbase course and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

a. Place drainage course on subgrades free of mud, frost, snow, or ice.

b. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1) Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2) Place drainage course 6 inches or less in compacted thickness in a single layer.
3) Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
1) Compact each layer of drainage course to required cross sections and thicknesses to not less than 98 percent of maximum dry unit weight according to ASTM D 698.

FIELD QUALITY CONTROL

a. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1) Determine prior to placement of fill that site has been prepared in compliance with requirements.
2) Determine that fill material and maximum lift thickness comply with requirements.
3) Determine, at the required frequency, that in-place density of compacted fill complies with requirements.

b. Owner’s Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

a. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

a. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Engineer.

a. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:

1) Paved: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area, but in no case fewer than three tests.

2) Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length, but no fewer than two tests.
3) Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.

b. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

PROTECTION

c. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

d. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1) Scarify or remove and replace soil material to depth as directed by Engineer; reshape and recompact.

e. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1) Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

DISPOSAL OF SURPLUS AND WASTE MATERIALS

a. Transport surplus satisfactory soil and topsoil to designated storage areas on Owner's property or remove from site and legally dispose as directed by Engineer. Stockpile or spread soil as directed by Engineer.

1) Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

PART 95 - END OF SECTION 312000

SECTION 312500 - EROSION AND SEDIMENTATION CONTROL

PART 1 -- GENERAL

1.1 THE REQUIREMENTS

A. Furnish all labor, equipment and materials required to complete all work associated with providing erosion and sedimentation control and other related and incidental work as required to complete the work on the Drawings and specified herein.

B. It is the intent of this Specification that the Contractor conducts the construction activities in such a manner that erosion of disturbed areas and off site sedimentation be prevented.

C. All work under this Contract shall be done in conformance with and subject to the limitations of the North Carolina Rules and Regulations for Erosion and Sedimentation Control as adopted by the North Carolina Sedimentation Control Commission (15 NCAC, Chapter 4).

D. Refer to the Construction Sequence on the Drawings for additional and specific requirements.

E. The Contractor shall familiarize himself and comply with all provisions of the Erosion and Sedimentation Control Permit obtained for this project and provided in Appendix A – Permits.

F. Due to the nature of the work required by this Contract, it is anticipated that the location and nature of the erosion and sedimentation control devices will be adjusted on several occasions to reflect the current phase of construction. The construction schedule adopted by the Contractor will impact the placement and need for specific devices required for the control of erosion. The Contractor shall develop and implement such additional techniques as may be required to minimize erosion and off-site sedimentation at no additional cost to the Owner. The location and extent of erosion and sedimentation control devices shall be revised at each phase of construction that results in a change in either the quantity or direction of surface runoff from constructed areas. All deviations from the erosion and sedimentation control provisions shown on the Drawings shall have the prior acceptance of the Engineer.

G. All excavations shall be in conformity with the lines, grades, and cross sections shown on the Drawings or established by the Engineer. Any excavation or disturbance beyond the limits of this project is strictly prohibited without the approval of the Engineer, installation of additional erosion control measures as necessary, and modification of the Erosion and Sedimentation Control Permit.

H. Drawings approved by North Carolina Department of Environmental and Natural Resources (NCDENR) and the City of Raleigh shall be used and followed unless otherwise modified and directed by NCDENR and the City of Raleigh. Additional erosion control devices may be required to keep sedimentation on Project site.

I. NCDENR and/or the City of Raleigh may require additional erosion control devices to be installed based on periodic site inspections.

1.2 RELATED SECTIONS

A. Division 31, Section “Site Clearing”

B. Division 31, Section “Earth Moving”

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of other requirements of these specifications, all work hereunder shall conform to the applicable requirements of the referenced portions of the following documents, to the extent that the requirements therein are not in conflict with the provisions of this Section.

1. 15A NCAC, Chapter 4 (NC Sedimentation Pollution Control Act of 1973)
2. NCDENR Construction Stormwater General Permit (NCG010000)
3. City of Raleigh Stormwater and Erosion Control Requirements

1.4 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General and Supplementary Conditions and Division 01 Specification Section - Submittals, the Contractor shall submit the following:

1. Name and location of all material suppliers.
2. Certificate of compliance with the standards specified above for each source of each material.
3. List of disposal sites for waste and unsuitable materials and all required permits for use of those sites.
4. Monitoring and Record Keeping Log sheet.

1.5 EROSION AND SEDIMENTATION CONTROL DEVICES

A. Erosion and sedimentation control devices shall be incorporated into the work and be constructed at the locations shown on the Drawings. Dimensions shall be as shown on the Drawings. Other devices, as necessary and acceptable to the Engineer shall be installed as required.

B. No changes in the Contract Sum or the Contract Time will be authorized for additional erosion control devices required to keep sedimentation on Project site.

1.6 GUARANTEE

A. All restoration and revegetation work shall be subject to the one-year guarantee period of the Contract as specified in the General Conditions.

PART 2 -- MATERIALS

2.1 GENERAL

A. Materials for use in erosion and sedimentation control devices shall be in accordance with the North Carolina Erosion and Sediment Control Planning and Design Manual.

2.2 CLASS 57 STONE

A. Class 57 stone shall meet the requirements of Aggregate Standard Size No. 57 as defined by NCDOT Standard Specifications.

2.3 SILT FENCE

A. Silt Fence shall be a woven geotextile filter fabric made specifically for sediment control. Filter fabric shall not rot when buried and shall resist attack from soil chemicals, alkalies and acids in the pH range from 2 to 13, and shall resist damage due to prolonged ultraviolet exposure. Filter fabric shall be Type FX-11, as manufactured by Carthage Mills, Type GTF-180, as manufactured by LINQ Industrial Fabrics, Amoco 2130 as manufactured by Amoco Fabrics & Fibers Co.

B. Filter fabric for the silt fence shall have the following minimum properties:

	Value	Test Method
Grab Tensile Strength	110 lbs	ASTM D 4632
Grab Elongation	15%	ASTM D 4632
Trapezoid Tear Strength	50 lbs	ASTM D 4533
Mullen Burst Strength	270 lbs	ASTM D 3786
Puncture Strength	60 lbs	ASTM D 4833
Retained Strength (500 hrs. accelerated UV exposure)	80%	ASTM D 4355
Filtration Efficiency	75%	VTM-51
Flow Rate	.30 gal/ft^2/min	VTM-51
Height	36 inches	

C. Posts for silt fence shall be steel and shall have the following properties:

ASTM Designation:	ASTM A702
Length:	5-Feet Long (T-Type)
Weight:	1.25#/Foot (min.)
Area of Anchor Plate:	14 Sq. In.

Note: Five (T) Fasteners shall be furnished with each post.

D. Wire Fabric for the silt fence shall have the following properties:

Wire Fabric Designation:	832-12-10-12.5 Class 1 Designation: ASTM A116
Width:	32"
Number of Line Wires:	8
Stay Wire Spacing:	12
Line and Stay Wires:	12.5 Ga.
Top and Bottom Wires:	10 Ga.
Wire Coating:	ASTM Class 1 Zinc Coating

2.4 STONE FOR EROSION CONTROL

A. The Contractor shall place Stone for Erosion Control as shown on the Drawings, as specified herein and as specified in Section 1042-1 of the NCDOT Standard Specifications. The Stone for Erosion Control shall be Class (A) or Class (B), as shown on the Drawings.

2.5 SYNTHETIC GEOTEXTILE FILTER FABRIC (Correlates with Type II – Geotextile on Drawings)

The filter fabric shall have the following mechanical properties:

Geotextile Construction	Woven
Mass per Unit Area (Unit Weight), ASTM D52611 (oz/yd^2)	5.6
Ultraviolet Resistance, (500 hrs.) ASTM D4355, Average % Strength Retention	90
Grab Tensile Strength (lbs.) ASTM D4632	$390^{(1)}X250^{(2)}$ 370X250
Grab Tensile Elongation (%) ASTM D4632	20 MAX
Wide Width Tensile Strength, (lbs./in.) ASTM D4595	N/A
Burst Strength, ASTM D3786, Diaphragm Method (psi)	480
Apparent Opening Size (AOS), (mm), ASTM D4751	0.21
Permittivity at 50 mm constant head (sec^{-1}), ASTM D4491	N/A
Puncture Resistance, ASTM D4833 (lb)	135

* MINIMUM AVERAGE ROLL VALUE (MARV)
(1) Warp Direction
(2) Fill Direction

Each roll of fabric will be visually inspected by the Engineer or his representative. The Engineer reserves the right to sample and test at any time and reject, if necessary, any material based on visual inspection or verification tests.

PART 3 -- EXECUTION

3.1 INSTALLATION AND MAINTENANCE

A. Erosion and sedimentation control devices shall be established prior to clearing operations in a given area.

B. The Contractor shall furnish the labor, materials and equipment required for routine maintenance of all erosion and sedimentation control devices. Maintenance shall be scheduled as required for a particular device to maintain the removal efficiency and intent of the device. Maintenance shall include but not be limited to 1) the removal and satisfactory disposal of trapped sediments from basins or silt barriers and 2) replacement of filter fabrics used for silt fences. Sediment removed

from erosion and sedimentation control devices shall be disposed of in locations that will not result in off site sedimentation as acceptable to the Engineer, at no additional cost to the Owner.

C. The Contractor shall install rain gauge and maintain Monitoring and Record Keeping Logs as per the requirements of the NCDENR Construction Stormwater General Permit (NCG010000) and the City of Raleigh.

D. The Contractor shall provide temporary or permanent ground cover adequate to restrain erosion on erodible slopes or other areas that will be left unworked for periods exceeding 7 calendar days for 3:1 or greater slopes, and 14 calendar days for completion of any phase of grading. Permanent ground cover to be provided within 15 working days or 90 calendar days (whichever is shorter) following completion of construction. No specific payment will be made for temporary ground cover. The Engineer may direct the Contractor to erect and maintain additional erosion control measures at other locations not shown on the Drawings.

E. All streets around the construction area shall be scraped as necessary to prevent accumulation of dirt and debris.

F. The Contractor shall provide adequate means to prevent any sediment from entering any storm drains, curb inlets, ditches, streams, or bodies of water downstream of any area disturbed by construction. Excavation materials shall be placed upstream of any trench or other excavation to prevent sedimentation of off-site areas. In areas where a natural buffer area exists between the work area and the closest stream or water course, this area shall not be disturbed.

3.2 TEMPORARY CONSTRUCTION ENTRANCES

A. Temporary construction entrances shall be constructed as necessary to comply with regulations and requirements stated above and as specified herein. The temporary construction entrances shall be constructed and maintained to the satisfaction of the Engineer until the project is completed and final clean-up of the project has been finished. Proper maintenance shall include, but not be limited to, the periodic replacement of NCDOT approved 2” – 3” course aggregate washed stone. Pad to be 50’L x 25’W x 6”D at a minimum and placed on geotextile fabric. Clean stone and cleaning up of stone scattered away from the temporary construction entrance by the use of the entrance. The cost of the temporary construction entrances shall include the excavation, grading, placement of stone, removal of the stone, and all maintenance activities required.

3.3 SILT FENCE

A. Silt fence shall be erected as shown on the Drawings and specified herein and as necessary to comply with regulations and requirements stated above. Silt fence shall be erected and maintained to the satisfaction of the Engineer until a vegetative ground cover has been established. Proper maintenance shall include, but not be limited to, the periodic removal of trapped sediments and replacement of the filter fabric should it deteriorate to a point that in the opinion of the Engineer it will no longer provide an adequate runoff filter. Replacement of the filter fabric, if required by the Engineer, will be at the Contractor's expense.

B. Silt fence shall be erected around all catch basins which are located downstream from any construction work. Should any catch basins be indicated to be relocated or modified, silt fence shall be utilized until work is completed on the catch basins.

C. Upon completion of the project, the Contractor shall remove all silt fence in areas where a stand of grass has been established and erosion is no longer evident. Removal of the remainder of the silt fence shall occur as other areas are established. Removal of any silt fence shall be permitted only with the prior approval of the Engineer.

3.4 STONE FILTERS

A. Stone filters shall be constructed as necessary to comply with regulations and requirements stated above and as specified herein. Stone filters shall be constructed and maintained to the satisfaction of the Engineer until a vegetative ground cover has been established. Proper maintenance will include, but not be limited to, the periodic removal of trapped sediments and replacement of stone. The cost of the stone filters shall include the excavation, grading, washed stone, mesh hardware cloth, steel post, etc., and all maintenance activities required.

3.5 ROCK DAMS

A. Rock dams shall be constructed as necessary to comply with regulations and requirements stated above and as specified herein. The rock dams shall be constructed and maintained to the satisfaction of the Engineer until a vegetative ground cover has been established. Proper maintenance will include, but not be limited to, the periodic removal of trapped sediments. The cost of the rock dams shall include the excavation, grading, stone for erosion control or rip rap, washed stone, etc., and all maintenance activities required.

3.6 CLASS 1 RIPRAP AND STONE FOR EROSION CONTROL

A. The Contractor shall place rip rap as necessary to comply with regulations and requirements stated above and as specified herein.

B. Riprap shall be graded so that the smaller stones are uniformly distributed through the mass. The Contractor may place the stone by mechanical methods, augmented by hand placing where necessary or ordered by the Engineer. The placed rip rap shall form a properly graded, dense, neat layer of stone. The placed rip rap shall have a minimum depth of 24-inches and shall have a layer of synthetic geotextile filter fabric as specified below placed between the soil and the stone.

C. Stone for Erosion Control shall be dumped and placed in such a manner that the larger rock fragments are uniformly distributed throughout the rock mass and the smaller fragments fill the voids between the larger fragments. Rearranging of individual stones by equipment or by hand shall only be required to the extent necessary to secure the results specified above and to protect structures from damage when rock material is placed against the structures. The placed stone shall be the minimum thickness shown on the Drawings and shall have a layer of synthetic geotextile filter fabric as specified below placed between the soil and the stone.

3.7 FURNISH AND PLACE SYNTHETIC GEOTEXTILE FILTER FABRIC

A. During all periods of shipment and storage, the fabric shall be wrapped in heavy-duty protective covering which will protect the fabric from sunlight, mud, dust, dirt, and debris. The fabric shall not be exposed to temperatures greater than 140°F. After the protective covering has been removed, the fabric shall not be left uncovered under any circumstances for longer than three (3) days.

B. Filter fabric shall be installed in such a manner that all splice joints are provided with a minimum overlap of 12-inches. Field splices of filter fabric shall be anchored with anchor pins to insure that required overlap is maintained. At the time of installation, the fabric will be rejected if it has defects, rips, holes, flaws, deteriorations, or damage incurred during manufacture, transportation, or storage.

C. Backfilling operations shall be done so as to prevent damage to the filter fabric. Damaged sections of filter fabric shall be replaced at no cost to the Owner.

D. Installation of filter fabric shall be done in a manner so as not to rupture, tear, puncture, cut, or abrade the materials. Where such damage occurs, filter fabric will be replaced. Filter fabric shall be protected by an opaque, waterproof, and oil proof covering during transportation and storage. The fabric shall be protected from exposure to sunlight. The maximum cumulative time of exposure to sunlight during transportation, storage, handling, and installation shall not exceed 3 days.

3.8 CURB INLET PROTECTION

A. Curb inlet protection shall be constructed as necessary to comply with regulations and requirements stated above and as specified herein. Curb inlet protection shall be constructed and maintained to the satisfaction of the Engineer until a vegetative ground cover has been established. Proper maintenance will include, but not be limited to, the periodic removal of trapped sediments and replacement of stone. The cost of the stone filters shall include the washed stone, mesh hardware cloth, steel post, etc., and all maintenance activities required.

3.9 STONE FILTER INLET PROTECTION

A. Stone filter inlet protection shall be constructed as necessary to comply with regulations and requirements stated above and as specified herein. Stone filter inlet protection shall be constructed and maintained to the satisfaction of the Engineer until a vegetative ground cover has been established. Proper maintenance will include, but not be limited to, the periodic removal of trapped sediments and replacement of stone. The cost of the stone filters shall include the excavation, grading, washed stone, mesh hardware cloth, steel post, etc., and all maintenance activities required.

PART 4 -- MEASUREMENT AND PAYMENT (Not Used)

END OF SECTION 312500

SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes concrete paving including the following:

1. Cast-in-Place Concrete Paving – Pedestrian.
2. Cast-in-Place Concrete Paving – Surface Seeded.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for general building applications of concrete.
2. Section 321373 "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans, and ground granulated blast-furnace slag.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to concrete paving, including but not limited to, the following:

a. Concrete mixture design.
b. Quality control of concrete materials and concrete paving construction practices.

2. Require representatives of each entity directly concerned with concrete paving to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete manufacturer.
d. Concrete paving subcontractor.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer and testing agency.

B. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Glass aggregate.
3. Steel reinforcement and reinforcement accessories.
4. Admixtures.
5. Curing compounds.
6. Applied finish materials.
7. Bonding agent or epoxy adhesive.
8. Joint fillers.

C. Material Test Reports: For each of the following:

1. Aggregates: Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

C. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated.

1. Personnel conducting field tests must be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

D. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockups of full-thickness sections of concrete paving to demonstrate typical joints; surface finish, texture, and color; curing; and standard of workmanship.
2. Build mockups of concrete paving finish type in a location as directed by Landscape Architect. Mock-up sizes as follows:
   a. Concrete Paving – Pedestrian, Standard Gray with Light Sand Finish to match existing Standard Gray concrete paving at Ellipse.
      1) 10’ x 10’, with radius edge to match smallest radius around pod planter edge. Mock-up to include minimum of two (2) saw-cut joints running parallel to radial edge of mock-up.
   b. Concrete Paving – Surface Seeded, Colored with Light Sand Finish and Silica Carbide and Crushed Glass.
      1) 10’ x 10’, with radius edge to match smallest radius around pod planter edge. Mock-up to include minimum of two (2) saw-cut joints running parallel to radial edge of mock-up.
3. Build mockups of each curb and edge restraint in a location directed by Landscape Architect, and not less than 5’ in length.
4. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

1.8 FIELD CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow.

3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

C. Hot-Weather Concrete Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 unless otherwise indicated.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for all curves.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

C. Automatic Machine for Curb placement may not be used.

2.3 STEEL REINFORCEMENT

A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 60 percent.

B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420); deformed.

C. Low-allow Steel Reinforcing Bars ASTM A 706/A 706/M, deformed.

D. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) plain-steel bars. Cut bars true to length with ends square and free of burrs.

E. Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60 (Grade 420), plain-steel bars.

F. Tie Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

G. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

H. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.

I. Zinc Repair Material: ASTM A 780.

2.4 CONCRETE MATERIALS

A. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Portland Cement: ASTM C150/C150M, gray portland cement Type I, Type I/II, or Type III. Supplement with the following:

a. Fly Ash: ASTM C618, Class F.
b. Slag Cement: ASTM C989/C989M, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C33/C33M, Class 3M coarse aggregate or better uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.

C. Air-Entraining Admixture: ASTM C260/C260M.

D. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

E. Water: Potable and complying with ASTM C94/C94M.

2.5 CURING MATERIALS

A. Water: Potable.

B. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

1. Products: Subject to compliance with requirements.

C. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, dissipating.

1. Products: Subject to compliance with requirements.

2.6 RELATED MATERIALS

A. Joint Fillers: ASTM D1751, asphalt-saturated cellulosic fiber in preformed strips.

B. Bonding Agent: ASTM C1059/C1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

C. Epoxy-Bonding Adhesive: ASTM C881/C881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:

1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

D. Chemical Surface Retarder: Water-soluble, liquid, set retarder with color dye, for horizontal concrete surface application, Refer to manufacturer’s instructions for set time of surface retarder. Provide mockup for approval.

1. Products: “Top Cast” by Grace Construction Products or Landscape Architect approved equal.
   a. Number code: 5
   b. Etch/Aggregate Size to Expose: Lt. Sandblast Finish
   c. Coverage: 250/350 S.F. / Gal.
   d. Color: Lt. Blue

E. Recycled Glass Aggregate.

1. Basis of Design: Size 1 Terrazzo Glass or approved equal, Color TDB. American Specialty Glass, 829 North 400 West North Salt Lake, UT 84054, Phone (801) 294-4222.

2.7 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301 (ACI 301M), for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash or Pozzolan: 25 percent.
2. Ground Granulated Blast-Furnace Slag: 50 percent.
3. Silica Fume: 10 percent
4. Combined Fly Ash, Pozzolan, and Silica Fume: 35 percent, with fly ash or pozzolan not exceeding 15 or 25 percent, respectively and silia fume not exceeding 10 percent.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content, 3/4-inch (19-mm) Nominal Maximum Aggregate Size: **6** percent plus or minus 1-1/2 percent.

D. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use high-range, water-reducing, or plasticizing admixture in concrete as required for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

E. Concrete Mixtures: Normal-weight concrete.

1. Compressive Strength (28 Days): 3000 psi (20.7 MPa).
2. Maximum W/C Ratio at Point of Placement: 0.45.
3. Slump Limit: 4 inches (200 mm), plus or minus 1 inch (25 mm).

2.8 COLORING, TEXTURE AND SEALING MATERIALS *(CONCRETE PAVING – SURFACE SEEDED)*

A. Preferred Installer: Carolina Bomanite Corporation or similar, 4933 Chastain Ave., Charlotte NC 28217. Contact John Fletcher 704.525.8585.

B. Brickform color hardener shall be applied to the surface at a ratio of approximately one lb. per s.f. Color to be Medium Gray with silicon carbide (36 mesh) and #00 crushed colored glass added, each at 10% by weight.

C. CHI 015 Surface Deactivaor will be used to achieve the desired texture.

D. Slabs shall be sealed with a silane sealer in accordance with the manufacturer's recommendations.

E. Color and finish to match Landscape Architect's Sample.

2.9 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph (5 km/h).
2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes).
3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch (13 mm) according to requirements in Section 312000 "Earth Moving."

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

C. No straight forms for curving walks or elements.

3.4 INSTALLATION OF STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete and to match existing concrete jointing at Ellipse. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
2. Provide tie bars at sides of paving strips where indicated.
3. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
1. Extend joint fillers full width and depth of joint.
2. Terminate joint filler not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) below finished surface if joint sealant is indicated.
3. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
4. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.

5. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:

1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 (ACI 301M) requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to ACI 301 (ACI 301M) by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement dowels and joint devices.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

3.7 SPECIAL FINISHES

A. Concrete Cast-in-Place Concrete Paving – Pedestrian.

1. Concrete Paving to match existing Standard Gray with Light Sand Finish concrete paving at Ellipse.
2. The area to receive Light Sand Finish concrete shall have the sub-grade prepared as required as for any concrete slab on grade on the site.
3. The formwork shall be installed in accordance with the drawings. Light Sand Finish shall be the thickness depicted on the drawings.
4. Control joints and/or isolation joints shall be provided in accordance with the drawings and the guidelines established by the American Concrete Institute. As with any concrete slab, Light Sand Finish concrete usually contains construction joints, control joints and expansion joints. The contractor shall advise and work with the architect/engineer to determine the best location for these joints to minimize the visibility of the joints and to minimize unsightly cracking.
5. All concrete flatwork shall be performed under the supervision of a craftsman who has completed the American Concrete Institute (ACI) Concrete Flatwork Finisher and Technician (ACICFFT) training and has five years of experience installing Light Sand Finish.
6. The concrete shall be placed and screeded to the finished grade, and floated to a uniform surface using standard finishing techniques.
7. Surface Deactivator will be applied and cleaned off with proper equipment.
8. After the initial curing period the surface of the slab shall be sealed with approved silane based sealer.

B. Cast-in-Place Concrete Paving – Surface Seeded.

1. Concrete Paving to be Colored with Light Sand Finish and Silica Carbide and Crushed Glass.
2. The area to receive Light Sand Finish concrete shall have the sub-grade prepared as required as for any concrete slab on grade on the site.
3. The formwork shall be installed in accordance with the drawings. Crushed Glass Surface Seeding shall be the thickness depicted on the drawings.
4. Seed crushed glass on top of concrete at 1 1/4 lbs. per square foot for 70-80% coverage.
5. Control joints and/or isolation joints shall be provided in accordance with the drawings and the guidelines established by the American Concrete Institute. As with any concrete slab, Light Sand Finish concrete usually contains construction joints, control joints and expansion joints. The contractor shall advise and work with the architect/engineer to determine the best location for these joints to minimize the visibility of the joints and to minimize unsightly cracking.
6. All concrete flatwork shall be performed under the supervision of a craftsman who has completed the American Concrete Institute (ACI) Concrete Flatwork Finisher and Technician (ACICFFT) training and has five years of experience installing Light Sand Finish.
7. The concrete shall be placed and screeded to the finished grade, and floated to a uniform surface using standard finishing techniques.
8. Surface Deactivator will be applied and cleaned off with proper equipment.

9. After the initial curing period the surface of the slab shall be sealed with approved silane based sealer.

3.8 INSTALLATION TOLERANCES

A. Uniformly place the concrete to the specified elevations.

B. Apply color hardener at approximately 70 s.f. per pail

C. Complete the finishing process to create a smooth, compacted surface to the concrete.

D. Uniformly apply the CHI 015 surface treatment.

E. Install saw cut control joints in a timely manner to minimize random cracking.

F. Remove the surface down to the fine aggregate using pressurized equipment. Care shall be taken to not leave any deep or shallow inconsistencies in the overall Light Sand Finish.

G. Evenly apply the recommended silane sealer after manufacturer recommended cure time.

H. After 28 days of cure time, install joint sealant in expansion joints. Color TBD.

I. Final clean up of job site

3.9 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

a. Water.
b. Continuous water-fog spray.
c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period, using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.10 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 (ACI 117M) and as follows:

1. Elevation: 3/4 inch (19 mm).
2. Thickness: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
3. Surface: Gap below 10-feet- (3-m-) long; unleveled straightedge not to exceed 1/2 inch (13 mm).
4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches (13 mm per 300 mm) of tie bar.
5. Lateral Alignment and Spacing of Dowels: 1 inch (25 mm).
6. Vertical Alignment of Dowels: 1/4 inch (6 mm).
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches (6 mm per 300 mm) of dowel.
8. Joint Spacing: 3 inches (75 mm).
9. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.
10. Joint Width: Plus 1/8 inch (3 mm), no minus.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C172/C172M will be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each day’s pour of each concrete mixture exceeding 5 cu. yd. but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof. or fraction thereof of each concrete mixture placed each day.

a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing to be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C231/C231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when it is 80 deg F (27 deg C) and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C31/C31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C39/C39M; test one specimen at seven days and two specimens at 28 days.

a. A compressive-strength test to be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).

D. Test results to be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests to contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency will make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.12 REPAIR AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

SECTION 321373 - CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cold-applied joint sealants.
2. Joint-sealant backer materials.
3. Primers.

B. Related Requirements:

1. Section 079200 "Joint Sealants" for sealing nontraffic and traffic joints in locations not specified in this Section.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Concrete pavement joint sealants.
2. Joint-sealant backer materials.

B. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of joint sealant.

C. Samples for Verification: Actual sample of finished products for each kind and color of joint sealant required.

1. Size: Joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Paving-Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For Installer.

B. Product Certificates: For each type of joint sealant and accessory.

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Installers: Entity that employs installers and supervisors who are trained and approved by manufacturer.

1.6 PRECONSTRUCTION TESTING

A. Product Testing: Test joint sealants using a qualified testing agency.

1.7 MOCKUPS

A. Contractor shall provide a mockup of joint sealants for each different color and type of concrete paving for approval by Landscape Architect.

1.8 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C).
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain joint sealants from single manufacturer for each sealant type.

2.2 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backer materials, and other related materials that are compatible with one another and with joint substrates under conditions of service

and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

2.3 COLD-APPLIED JOINT SEALANTS

A. Single-Component, Self-Leveling, Silicone Joint Sealant: ASTM D5893/D5893M, Type SL, Color to match adjacent paving.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Crafco Inc; RoadSaver Silicone SL.
b. Dow Corning Corporation; 890-SL.
c. Pecora Corporation; 300 SL.

2.4 JOINT-SEALANT BACKER MATERIALS

A. Joint-Sealant Backer Materials: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by joint-sealant manufacturer, based on field experience and laboratory testing.

B. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.

2.5 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Before installing joint sealants, clean out joints immediately to comply with joint-sealant manufacturer's written instructions.

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions.

C. Install joint-sealant backers to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of joint-sealant backer materials.
2. Do not stretch, twist, puncture, or tear joint-sealant backer materials.
3. Remove absorbent joint-sealant backer materials that have become wet before sealant application and replace them with dry materials.

D. Install joint sealants immediately following backer material installation, using proven techniques that comply with the following:

1. Place joint sealants so they fully contact joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants in accordance with the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:

1. Remove excess joint sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING AND PROTECTION

A. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.

B. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

END OF SECTION 321373

SECTION 321400 - UNIT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Decorative concrete pavers.
   2. Decorative aggregate.

B. Related Requirements:
   1. Section 321313 "Concrete Paving" for concrete base under unit pavers and for cast-in-place concrete curbs and gutters serving as edge restraints for unit pavers.
   2. Section 312000 “Earth Moving” for preparing subgrades, excavation and backfill, rough grading, base courses, and geotextile.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data:

   1. For materials other than water and aggregates.
   2. For the following:

      a. Decorative concrete pavers.
      b. Mortar and grout materials.
      c. Decorative aggregate.

B. Samples for Verification: For full-size units of each type of unit paver indicated. Assemble no fewer than five Samples of each type of unit on suitable backing and grout joints. Include Samples of the following:

   1. Decorative concrete pavers: Minimum of 3 pavers to show full range of color and surface finish, minimum of 32-inch by 32-inch by full thickness sample. Provide sealer on one half of the sample’s exposed finish surface.
   2. Decorative aggregate.
   3. Joint materials.
   4. Caulk sealant.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Adhesion and Compatibility Test Reports: From latex-additive manufacturer for mortar and grout containing latex additives.

C. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for unit pavers, indicating compliance with requirements.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For unit paving to include in maintenance manuals. Include product data for paver-care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1. Include yearly care instructions, including repairs to or replacement of pavers and joints, cleaning, and sealing.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified unit paving installer. Installer's field supervisor must have Concrete Paver Installer Certification from the Interlocking Concrete Pavement Institute (ICPI) with the following designations:

1. Commercial Paver Technician Designation.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution, and as follows.

1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Landscape Architect specifically approves such deviations in writing.
2. Maintain and protect approved mockups throughout construction for reference of expected aesthetics, quality, and workmanship.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
4. Mockups shall be located and installed as directed by Landscape Architect at time of mockup install.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Submit to latex-additive manufacturer, for testing as indicated below, Samples of flooring materials that will contact or affect mortar and grout that contain latex additives.

1. Use manufacturer's standard test methods to determine whether mortar and grout materials will obtain optimal adhesion with, and will be nonstaining to, installed brick and other materials constituting brick flooring installation.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Store liquids in tightly closed containers protected from freezing.

1.9 FIELD CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

B. Weather Limitations for Mortar and Grout:

1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F and higher.

a. When ambient temperature exceeds 100 deg F, or when wind velocity exceeds 8 mph and ambient temperature exceeds 90 deg F, set pavers within 1 minute of spreading setting-bed mortar.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of unit paver, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

2.2 CONCRETE PAVERS

A. Decorative Concrete Pavers: Trails Large; Alabaster; Large Marble, Large Yellow, Large Black.

1. Supplier: Concrete Collaborative or approved equal

    a. Thickness: As indicated on Drawings.
    b. Face Size and Shape: Custom Paver at 28¼” x 30¾”.
    c. Color: As indicated by manufacturer's designations.
    d. Certain pavers will need to be cut in order to achieve critical alignments to adjacent elements, see Drawings.

2.3 ACCESSORIES

A. Movement Joints
1. Paver installations must include Movement Joints at coves, corners, other changes in substrate plane, and over any expansion joints in the substrate. Movement Joints in stonework are also required at perimeter, at restraining surfaces, at penetrations and at the intervals described in the Tile Council of North America, Inc. (TCNA) Handbook Installation Method EJ171.
2. Silicone Caulking: Laticrete International, Inc.; LATASIL, Color: As selected by Landscape Architect from manufacturer’s full color range.
3. Preformed flexible foam strips complying with ASTM D1056, Grade 2A1.

B. Paver Joints
1. Latex Portland Cement Grout to be weather, frost, and shock resistant, conform to ISO 13007 requirements for CG2WAF, UL GREENGUARD Gold certified, as well as meet the following physical requirements:
    a. Compressive Strength (ANSI A118.7): 3,500 psi (24.1 MPa)
    b. Tensile Strength (ANSI A118.7): 510 psi (3.5 MPa)
    c. Flexural Strength (ANSI A118.7): 1,250 psi (8.6 MPa)
    d. Water Absorption (ANSI A118.7): < 5%
    e. Linear Shrinkage (ANSI A118.7): < 0.5 %
    f. Smoke & Flame Contribution (ASTM E84 Modified): 0
    g. VOC Content: 0.00 g/L
    h. Total VOC Emissions: ≤0.22 mg/m3

2. Basis of Design Product: PERMACOLOR Select, as manufactured by Laticrete International, Inc., Bethany, CT (203) 393-0010; Color as selected by Landscape Architect from manufacturer's full color range.

C. Paver Sealants
1. Colorless, stain- and slip-resistant sealer, not affecting color and physical properties of stone surfaces as recommended by sealer manufacturer for application indicated.
2. Basis of Design Product: STONETECH Bulletproof Sealer as manufactured by Laticrete International, Inc., Bethany, CT (203) 393-0010

D. Cleaner: Paver cleaner specifically formulated for paver type, finish, and applications indicated, as recommended by paver manufacturer and by sealer manufacturer. Do not use cleaning compounds containing acids, caustics, harsh fillers, or abrasives.

2.4 MORTAR SETTING-BED MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or Type II.

B. Hydrated Lime: ASTM C207, Type S.

C. Sand: ASTM C144.

D. Latex Additive: Manufacturer's standard water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed, and not containing a retarder.

E. Thin-Set Mortar for Bond Coat: Latex-portland cement mortar complying with ANSI A118.4.

1. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
2. Provide prepackaged, dry-mortar mix combined with acrylic resin liquid-latex additive at Project site.

F. Water: Potable.

G. Reinforcing Wire Fabric: Galvanized, welded wire fabric, 2 by 2 inches by 0.062 inch in diameter; comply with ASTM A1064/A1064M except for minimum wire size.

2.5 GROUT MATERIALS

A. Sand-Portland Cement Grout: ANSI A108.10, made of white or gray cement and white or colored aggregate as required to produce color indicated.

1. Colored Mortar Pigments for Grout: Natural and synthetic iron and chromium oxides, compounded for use in mortar and grout mixes. Use only pigments that

have proved, through testing and experience, to be satisfactory for use in portland cement grout.

B. Standard Cement Grout: ANSI A118.6, sanded.

C. High-Performance Cement Grout: ANSI A118.7, sanded.
   1. Polymer Type:
      a. Ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients.
      b. Acrylic resin in liquid-latex form for addition to prepackaged dry-grout mix.

D. Grout Colors: As selected by Architect from manufacturer's full range.

E. Water: Potable.

2.6 MORTAR AND GROUT MIXES

A. General: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing times, and other procedures needed to produce setting-bed and joint materials of uniform quality and with optimal performance characteristics. Discard mortars and grout if they have reached their initial set before being used.

B. Mortar-Bed Bond Coat: Mix neat cement and latex additive water to a creamy consistency.

C. Portland Cement-Lime Setting-Bed Mortar: Type M complying with ASTM C270, Proportion Specification.

D. Latex-Modified, Portland Cement Setting-Bed Mortar: Proportion and mix portland cement, sand, and latex additive for setting bed to comply with written instructions of latex-additive manufacturer and as necessary to produce stiff mixture with a moist surface when bed is ready to receive pavers.

E. Latex-Modified, Portland Cement Bond Coat: Proportion and mix portland cement, aggregate, and liquid latex for bond coat to comply with written instructions of liquid-latex manufacturer.

F. Thinset Mortar Bond Coat: Proportion and mix according to manufacturer's written instructions.

G. Job-Mixed Portland Cement Grout: Proportion and mix job-mixed portland cement and aggregate grout to match setting-bed mortar except omit hydrated lime and use enough water to produce a pourable mixture.

   1. Pigmented Grout: Select and proportion pigments with other ingredients to produce color required. Do not exceed pigment-to-cement ratio of 1 to 10, by weight.

2. Colored-Aggregate Grout: Produce color required by combining colored aggregates with portland cement of selected color.

H. Packaged Grout: Proportion and mix according to grout manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces indicated to receive unit paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Where unit paving is to be installed over waterproofing, examine waterproofing installation, with waterproofing Installer present, for protection from paving operations, including areas where waterproofing system is turned up or flashed against vertical surfaces.

C. Proceed with installation only after unsatisfactory conditions have been corrected and waterproofing protection is in place.

3.2 PREPARATION

A. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.

B. Sweep concrete substrates to remove dirt, dust, debris, and loose particles.

C. Proof-roll prepared subgrade according to requirements in Section 312000 "Earth Moving" to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive subbase and base course for unit pavers.

3.3 INSTALLATION, GENERAL

A. Do not use unit pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.

B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.

D. Handle protective-coated brick pavers to prevent coated surfaces from contacting backs or edges of other units. If, despite these precautions, coating does contact bonding surfaces of brick, remove coating from bonding surfaces before setting brick.

E. Joint Pattern: As indicated on drawings.

1. Provide joint filler at waterproofing that is turned up on vertical surfaces unless otherwise indicated; where unfilled joints are indicated, provide temporary filler or protection until paver installation is complete.

F. Tolerances:

1. Do not exceed 1/16-inch unit-to-unit offset from flush (lippage) nor 1/8 inch in 24 inches and 1/4 inch in 10 feet from level, or indicated slope, for finished surface of paving.

G. Expansion and Control Joints:

1. Provide for sealant-filled joints at locations and of widths indicated. Provide compressible foam filler as backing for sealant-filled joints unless otherwise indicated; where unfilled joints are indicated, provide temporary filler until paver installation is complete. Install joint filler before setting pavers. Sealant materials and installation are specified in Section 079200 "Joint Sealants."

3.4 MORTAR SETTING-BED APPLICATIONS

A. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.

B. Apply mortar-bed bond coat over surface of concrete subbase about 15 minutes before placing mortar bed. Do not exceed 1/16-inch thickness for bond coat. Limit area of bond coat to avoid its drying out before placing setting bed.

C. Apply mortar bed over bond coat; spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.

D. Mix and place only that amount of mortar bed that can be covered with pavers before initial set. Before placing pavers, cut back, bevel edge, and remove and discard setting-bed material that has reached initial set.

E. Place pavers before initial set of cement occurs. Immediately before placing pavers on mortar bed, apply uniform 1/16-inch-thick bond coat to mortar bed or to back of each paver with a flat trowel.

F. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in

a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.

G. Spaced Joint Widths: Provide 1/4-inch nominal joint width with variations not exceeding plus or minus 1/16 inch.

H. Grouted Joints: Grout paver joints complying with ANSI A108.10.

I. Grout joints as soon as possible after initial set of setting bed.

1. Force grout into joints, taking care not to smear grout on adjoining surfaces.
2. Clean pavers as grouting progresses by dry brushing or rubbing with dry burlap to remove smears before tooling joints.
3. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
4. If tooling squeezes grout from joints, remove excess grout and smears by dry brushing or rubbing with dry burlap and tool joints again to produce a uniform appearance.

J. Cure grout by maintaining in a damp condition for seven days unless otherwise recommended by grout or liquid-latex manufacturer.

3.5 REPAIRING, POINTING, AND CLEANING

A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

B. Pointing: During tooling of joints, enlarge voids or holes and completely fill with grout. Point joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.

C. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.

END OF SECTION 321400

SECTION 323253 - STONE RETAINING WALLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Stacked Stone
2. Stone Retaining Wall

B. Related Sections:

1. Section 312000 “Earth Moving” for subgrade preparation and materials.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each variety of stone, stone accessory, and manufactured product.

B. Samples: For colored mortar and polymeric sand and other items involving color selection.

C. Samples for Verification:

1. For stone: Including at least three samples at each set and show the full range of color and other visual characteristics in completed work.
2. For each color of mortar required.
3. For each color of polymeric sand required.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Material Test Reports:

1. Stone Test Reports: For each stone variety proposed for use on Project, by a qualified testing agency, indicating compliance with required physical properties, other than abrasion resistance, according to referenced ASTM standards. Base reports on testing done within previous five years.
2. Sealant Compatibility and Adhesion Test Report: From sealant manufacturer indicating that sealants will not stain or damage stone. Include interpretation of test

results and recommendations for primers and substrate preparation needed for adhesion.

3. Sample Stone Material (Existing Wall):





1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer, with minimum of 3 successful projects comparable in scope of work indicated herein and on Drawings, who employs experienced stonemasons and stone fitters and are trained and approved for installation of stone retaining walls required for this Project.

B. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

C. Source Limitations for Stone: Obtain each variety of stone from one quarry with resources to provide materials of consistent quality in appearance and physical properties.

1. Quarry Qualifications: A qualified stone quarrier that participates in the Sustainable Stone Certification Program and is certified to the ANSI/NCS 373 Sustainable Production of Natural Dimension Stone standard by the NSF.
2. Fabricator Qualifications: A qualified stone fabricator that participates in the Sustainable Stone Certification Program and is certified to the ANSI/NSC 373 Sustainable Production of Natural Dimension Stone standard by the NSF.

D. Mockups: Build mockups to demonstrate aesthetic effects and quality of workmanship.

1. Build mockup of stacked stone as indicated on Drawings.

A. Include typical base and finished top construction.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 PERFORMANCE REQUIREMENTS

A. Stacked stone shall be non-structural, non-mortared

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store and handle stone and accessories to prevent deterioration or damage due to contaminants, breaking, scarring, chipping, or other causes.

B. Store geotextile fabrics in manufacturer's original packaging with labels intact. Store and handle geotextile fabrics to prevent deterioration or damage due to sunlight, chemicals, flames, temperatures above 160 deg F or below 32 deg F, and other conditions that might damage them. Verify identification of geosynthetics before use and examine them for defects as material is placed.

1.8 PROJECT CONDITIONS

A. Do not install stone that are damaged, scarred or broken.

B. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace stone damaged by frost or freezing.

PART 2 - PRODUCTS

2.1 DRY-STACK STONE

A. Stone: Sound, durable, natural sandstone, complying with ASTMC616/C616M, Classification I.

1. Basis of Design Product: Antique Brown, finish – split face, natural cleft top, bottom and back and chopped sides, stained strip with 25-percent stained jumpers, as supplied by Southern Stone Supply, Raleigh, NC, 919-570-1555, or approved equal.
2. Sizes: 2-8 inches thick, with strip stone 2-8 inches high by random lengths, minimum 12-inches long, and jumper stone 8 inch minimum high by random lengths, minimum 12-inches long.

2.2 MORTAR MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or Type II, except Type III may be used for cold-weather construction; natural color or white cement may be used as required to produce mortar color indicated.

1. Low-Alkali Cement: Not more than 0.60 percent total alkali when tested according to ASTM C114.

B. Hydrated Lime: ASTM C207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Mortar Cement: ASTM C1329/C1329M.

E. Masonry Cement: ASTM C91/C91M.

F. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in stone masonry mortar.

G. Colored Portland Cement-Lime Mix: Packaged blend of portland cement, hydrated lime, and mortar pigments. Mix produces color indicated or, if not indicated, as selected from manufacturer's standard colors. Pigments do not exceed 10 percent of portland cement by weight.

H. Colored Masonry Cement Mix: Packaged blend of masonry cement and mortar pigments. Mix produces color indicated or, if not indicated, as selected from manufacturer's standard colors. Pigments do not exceed 5 percent of masonry cement by weight.

I. Aggregate: ASTM C144 and as follows:

1. For pointing mortar, use aggregate graded with 100 percent passing No. 16 (1.18-mm) sieve.
2. Colored Aggregates: Natural-colored sand or ground marble, granite, or other sound stone; of color necessary to produce required mortar color.

J. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C494/C494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

K. Water: Potable.

2.3 MISCELLANEOUS ACCESSORIES

A. Sand for Setting Bed: Sound, sharp, washed, natural sand complying with gradation requirements in ASTM C33/C33M for fine aggregate.

B. Polymeric Sand for Joints: Manufacturer’s standard blend of fine, sharp, washed, natural sand complying with gradation requirements in ASTM C144/C144M for fine aggregate, and crystalline silica, complying with OSHA 29 CFR 1926.1153.

1. Basis of Design Product: Gator Maxx Sand G2 as manufactured by Alliance Designer Products Inc., Laval, Quebec, Canada, 866-212-1611, or approved equal.
2. Color: Beige.

2.4 MISCELLANEOUS INSTALLATION MATERIALS

A. Leveling Base: Comply with requirements in Section 312000 "Earth Moving" for base course.

B. Drainage Fill: Comply with requirements in Section 312000 "Earth Moving" for drainage course.

C. Nonreinforced-Soil Fill: Comply with requirements in Section 312000 "Earth Moving" for satisfactory soils.

1. Backfill and compact in lifts not exceeding 8 inches unless otherwise approved in writing by engineer.

D. Drainage Geotextile: Per Section 312000 “Earth Moving”. Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent.

1. Apparent Opening Size: No. 70 to 100 sieve, maximum; ASTM D4751.
2. Minimum Grab Tensile Strength: 110 lb; ASTM D4632.
3. Minimum Weight: 4 oz./sq. yd.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for excavation tolerances, condition of subgrades, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 STACKED STONE INSTALLATION

A. Do not use stone with chips, cracks, or other non-structural defects where such defects are exposed in the completed Work.

B. Leveling Base: Place and compact base material to thickness indicated and with not less than 95 percent maximum dry unit weight according to ASTM D698.

C. First Course: Place first course of stone for full length of wall. Place stone in firm contact with each other, properly aligned and level.

1. Tamp stone into leveling base as necessary to bring tops of stone into a level plane.

D. Subsequent Courses: Remove excess fill and debris from tops of stone in course below. Place stone in firm contact, properly aligned, and directly on course below.

1. Front (exposed face) shim or chink with smaller stones only if approved by Architect.
2. Stabilize stone coursing with polymeric sand, as necessary.

3.3 FILL PLACEMENT

A. Place, spread, and compact drainage fill and soil fill in uniform lifts for full width and length of embankment as wall is laid. Place and compact fills without disturbing alignment of stone. Where both sides of wall are indicated to be filled, place fills on both sides at same time. Begin at wall, and place and spread fills toward embankment.

1. Use only hand-operated compaction equipment within 48 inches of wall, or one-half of height above bottom of wall, whichever is greater.
2. Compact drainage fill and nonreinforced-soil fill to comply with Section 312000 "Earth Moving."

3.4 CONSTRUCTION TOLERANCES

A. Variation from Level: For bed-joint lines along walls, do not exceed 1-1/4 inches in 10 feet, 3 inches maximum.

B. Variation from Indicated Batter: For slope of wall face, do not vary from indicated slope by more than 1-1/4 inches in 10 feet.

C. Variation from Indicated Wall Line: For walls indicated as straight, do not vary from straight line by more than 1-1/4 inches in 10 feet.

D. Maximum Gap between Stone: 1/2 inch.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Comply with requirements in Section 312000 "Earth Moving" for field quality control.

3.6 ADJUSTING AND CLEANING

A. Remove and replace stone retaining wall construction of the following descriptions:

1. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if Architect approves methods and results.
2. Stone retaining walls that do not match approved Samples and mockups.
3. Stone retaining walls that do not comply with other requirements indicated.

B. Replace stone so stone retaining wall matches approved Samples and mockups, complies with other requirements, and shows no evidence of replacement.

C. Remove any visible markings and clean landscape boulders of dirt, stains, and debris prior to final acceptance by Architect.

3.7 EXCESS MATERIALS AND WASTE

A. Excess Stone: Place excess stone where directed by Owner for Owner's use.

B. Excess Accessory and Installation Material Waste: Remove excess accessory and installation material waste and legally dispose of off Owner's property.

END OF SECTION 323253

SECTION 323300 - SITE FURNISHINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Bench Type 1.
2. Bench Type 2.

B. Related Requirements:

1. Section 055000 “Metal Fabrications” for installing pods (planters).

2. Section 033000 "Cast-in-Place Concrete" for installing anchor bolts cast in concrete footings.
3. Section 312000 "Earth Moving" for excavation for installing concrete footings.

1.3 ACTION SUBMITTALS

A. Product Data: Manufacturer’s technical literature for each product specified, identifying the following:

1. Bench materials, dimensions, and finishes.
2. Selected product options.
3. Anchoring methods.

B. Samples: For each exposed product and for each color and texture specified.

C. Samples for Verification: For each type of exposed finish, not less than 6-inch- (152-mm-) long linear components and 4-inch- (102-mm-) square sheet components.

1. Include full-size Samples of bench materials. Approved samples may be incorporated into the Work.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates: For site furnishings manufactured with preservative-treated wood.

1. Indicate type of preservative used and net amount of preservative retained. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

B. Manufacturer's installation instructions.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For site furnishings to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. A manufacturer of site benches of the types and extent required for the Project with a documented history of successful in-service performance, and

   a. Has been in continuous operation for a period of not less than ten years, and
   b. Has the production capacity to service the Project.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Bench Replacement Planks: No fewer than two full-size units for each size indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's requirements for receipt of product delivered, inspection, storage, and handling.

B. Inventory and inspect the condition of site benches upon delivery. Reject damaged products and arrange for replacement.

C. Comply with the manufacturer's instructions for storage of benches prior to installation.
1. Store products off the ground on dry wood pallets. Do not stack products or pallets.
2. Protect products from damage resulting from construction operations.
3. If products are stored in the exterior environment for any length of time, remove metal pallet strapping and foam or plastic wrapping to avoid trapping moisture, condensation, or exposure to high humidity, to prevent staining or marring of surface finish.

D. Handle products during transport, unloading, and installation using tools and methods that preserve their condition and prevent damage, including use of fork extensions where required.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Basis of Design: Site benches manufactured by Form and Fiber, Inc., 803 East Mason Street, Mabank, TX, 75147. Tel: 903-603-9269 ext.1004; E-mail address: sales@formandfiber.com; Website address: www.formandfiber.com.

2.2 METAL BENCH TYPE 1

A. Description: Metal benches with wood seats integrated with landscape planter wall systems as follows:

1. Base Metal: Carbon steel complying with ASTM A36 or A1011, 0.25-inch (6.35 mm) thick unless otherwise indicated.

2. Metal Finish: Manufacturer's standard two-coat, baked-on finish consisting of epoxy prime coat and thermosetting polyester resin topcoat, and as follows:

   a. Epoxy Primer: Zinc rich epoxy primer, minimum 2.5 mil dry film thickness.
   b. Finish Coat: Polyester resin complying with AMAA 2604 Super Durable classification, minimum 1.2 mil thickness.

3. Wood Bench Seat: 2-inch-thick dressed lumber secured to bench base, in a weather resistant, thermally modified wood:

   a. Basis of Design: Thermory (Benchmark Ash).

B. Bench Dimensions: As indicated on Drawings.

C. Leveling Feet: Stainless steel leveling hardware consisting of anchor inset, mount type swiveling stud, and locking nut.
1. Thread Size: SAE NC 3/8-16.
2. Base diameter: 1.25-inch (31.75 mm).
3. Load capacity: 3750 lbs. (28315.6 kg) each.

2.3 METAL BENCH TYPE 2

A. Description: Metal benches with wood seats, as indicated on Drawings.

1. Base Metal: Carbon steel complying with ASTM A36 or A1011, 0.25-inch thick unless otherwise indicated.

2. Metal Finish: Manufacturer's standard two-coat, baked-on finish consisting of epoxy prime coat and thermosetting polyester resin topcoat, and as follows:

    a. Epoxy Primer: Zinc rich epoxy primer, minimum 2.5 mil dry film thickness.
    b. Finish Coat: Polyester resin complying with AMAA 2604 Super Durable classification, minimum 1.2 mil thickness.

3. Wood Bench Seat: 2-inch-thick dressed lumber secured to bench base, in a weather resistant, thermally modified wood:

    a. Basis of Design: Thermory (Benchmark Ash).

4.

B. Bench Dimensions: As indicated on Drawings.

2.4 FABRICATION

A. Metal Components: Form to required shapes and sizes with true, consistent curves, lines, and angles. Separate metals from dissimilar materials to prevent electrolytic action.

B. Welded Connections: Weld connections continuously. Weld solid members with full-length, full-penetration welds and hollow members with full-circumference welds. At exposed connections, finish surfaces smooth and blended, so no roughness or unevenness shows after finishing and welded surface matches contours of adjoining surfaces.

C. Exposed Surfaces: Polished, sanded, or otherwise finished; all surfaces smooth, free of burrs, barbs, splinters, and sharpness; all edges and ends rolled, rounded, or capped.

D. Factory Assembly: Factory assemble components to greatest extent possible to minimize field assembly. Clearly mark units for assembly in the field.

2.5 GENERAL FINISH REQUIREMENTS

A. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.6 STEEL FINISHES

A. Powder-Coat Finish: Manufacturer's standard polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.

B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.

C. Install site furnishings level, plumb, true, and securely anchored at locations indicated on Drawings.

3.3 CLEANING AND PROTECTION

A. Clean finished surfaces as recommended by the manufacturer.

B. Protect installed benches from damage with non-marking protection. Maintain dry, ventilated conditions for protection until final acceptance.

END OF SECTION 323300

SECTION 329113 - SOIL PREPARATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes planting soils and layered soil assemblies specified by composition of the mixes.

B. Related Requirements:
1. Section 311000 "Site Clearing" for topsoil stripping and stockpiling.
2. Section 329200 "Turf and Grasses" for placing planting soil for turf and grasses.
3. Section 329300 "Plants" for placing planting soil for plantings.

1.3 ALLOWANCES

A. Preconstruction and field quality-control testing are part of testing and inspecting allowance.

1.4 DEFINITIONS

A. AAPFCO: Association of American Plant Food Control Officials.

B. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.

C. CEC: Cation exchange capacity.

D. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.

E. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.

F. Imported Soil: Soil that is transported to Project site for use.

G. Layered Soil Assembly: A designed series of planting soils, layered on each other, that together produce an environment for plant growth.

H. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.

I. NAPT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through interlaboratory sample exchanges and statistical evaluation of analytical data.

J. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."

K. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

L. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.

M. SSSA: Soil Science Society of America.

N. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

O. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

P. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.

Q. USCC: U.S. Composting Council.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include recommendations for application and use.
2. Include test data substantiating that products comply with requirements.
3. Include sieve analyses for aggregate materials.
4. Material Certificates: For each type of imported soil and soil amendment and fertilizer before delivery to the site, according to the following:

    a. Manufacturer's qualified testing agency's certified analysis of standard products.

b. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SUIP #25.
c. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.

B. Samples: For each bulk-supplied material, 1-quart minimum volume of each in sealed containers labeled with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of composition, color, and texture.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For each testing agency.

B. Preconstruction Test Reports: For preconstruction soil analyses specified in "Preconstruction Testing" Article.

C. Field quality-control reports.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.

1.9 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction soil analyses on existing, on-site soil, salvaged topsoil, and imported, manufactured soil.

1. Notify Landscape Architect seven days in advance of the dates and times when laboratory samples will be taken.

B. Preconstruction Soil Analyses: For each unamended soil type, perform testing on soil samples and furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a qualified testing agency performing the testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.

1. Have testing agency identify and label samples and test reports according to sample collection and labeling requirements.

1.10 SOIL-SAMPLING REQUIREMENTS

A. General: Extract soil samples according to requirements in this article.

B. Sample Collection and Labeling: Have samples taken and labeled by Owner under the direction of the testing agency.

1. Number and Location of Samples: Minimum of three representative soil samples where directed by Landscape Architect for each soil to be used or amended for landscaping purposes.
2. Procedures and Depth of Samples: According to USDA-NRCS's "Field Book for Describing and Sampling Soils."
3. Division of Samples: Split each sample into two, equal parts. Send half to the testing agency and half to Owner for its records.
4. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

1.11 TESTING REQUIREMENTS

A. General: Perform tests on soil samples according to requirements in this article and provide soil test results to Owner and Landscape Architect.

B. Physical Testing:

1. Soil Texture: Soil-particle, size-distribution analysis by one of the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":

a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
b. Hydrometer Method: Report percentages of sand, silt, and clay.

2. Total Porosity: Calculate using particle density and bulk density according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
3. Water Retention: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
4. Saturated Hydraulic Conductivity: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods"; at 85% compaction according to ASTM D698 (Standard Proctor).

C. Chemical Testing:

1. CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."
2. Clay Mineralogy: Analysis and estimated percentage of expandable clay minerals using CEC by ammonium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 1- Physical and Mineralogical Methods."
3. Metals Hazardous to Human Health: Test for presence and quantities of RCRA metals including aluminum, arsenic, barium, copper, cadmium, chromium, cobalt, lead, lithium, and vanadium. If RCRA metals are present, include recommendations for corrective action.

4. Phytotoxicity: Test for plant-available concentrations of phytotoxic minerals including aluminum, arsenic, barium, cadmium, chlorides, chromium, cobalt, copper, lead, lithium, mercury, nickel, selenium, silver, sodium, strontium, tin, titanium, vanadium, and zinc.

D. Fertility Testing: Soil-fertility analysis according to standard laboratory protocol of SSSA NAPT NCR-13 including the following:

1. Percentage of organic matter.
2. CEC, calcium percent of CEC, and magnesium percent of CEC.
3. Soil reaction (acidity/alkalinity pH value).
4. Buffered acidity or alkalinity.
5. Nitrogen ppm.
6. Phosphorous ppm.
7. Potassium ppm.
8. Manganese ppm.
9. Manganese-availability ppm.
10. Zinc ppm.
11. Zinc availability ppm.
12. Copper ppm.
13. Sodium ppm and sodium absorption ratio.
14. Soluble-salts ppm.
15. Presence and quantities of problem materials including salts and metals cited in the Standard protocol. If such problem materials are present, provide additional recommendations for corrective action.
16. Other deleterious materials, including their characteristics and content of each.

E. Organic-Matter Content: Analysis using loss-by-ignition method according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."

F. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy, viable plants indicated. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients.

1. Fertilizers and Soil Amendment Rates: State recommendations in weight per 1000 sq. ft. for 6-inch depth of soil.
2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight per 1000 sq. ft. for 6-inch depth of soil.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Do not move or handle materials when they are wet or frozen.
4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

PART 2 - PRODUCTS

2.1 PLANTING SOILS

A. General: Soil amendments, fertilizers, and rates of application specified in this article are guidelines that may need revision based on testing laboratory's recommendations after preconstruction soil analyses are performed.

B. Planting-Soil Type 1: Existing, on-site surface soil, with the duff layer, if any, retained; and stockpiled on-site; modified to produce viable planting soil in accordance with recommendations in Soil Analysis Report.

C. Planting-Soil Type 2: Imported, Manufactured, Planting soil from off-site sources and consisting of manufacturer’s basic topsoil, blended in a manufacturing facility with sand, stabilized organic soil amendments, and other materials to produce viable planting soil.

1. Provide when quantities of Planting Soil Type 1 are insufficient.
2. Sources: Take imported, unamended soil from sources that are naturally well-drained sites where topsoil occurs at least 4 inches deep, not from agricultural land,]bogs, or marshes; and that do not contain undesirable organisms; disease-causing plant pathogens; or obnoxious weeds and invasive plants including, but not limited to, quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass.
3. Additional Properties of Imported Soil before Amending: Soil reaction of pH 6 to 7 and minimum of 4 percent organic-matter content, friable, and with sufficient structure to give good tilth and aeration.
4. Unacceptable Properties: Clean soil of the following:

    a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
    b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 5 percent by dry weight of the imported soil.

5. Provide soil Provide soil amendments and fertilizers of type, proportion and quantity according to recommendations in Soil Analysis Report.

2.2 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: T, with a minimum of 99 percent passing through a No. 8 sieve and a minimum of 75 percent passing through a No. 60 sieve.
2. Class: O, with a minimum of 95 percent passing through a No. 8 sieve and a minimum of 55 percent passing through a No. 60 sieve.

B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 (3.35-mm) sieve and a maximum of 10 percent passing through a No. 40 (0.425-mm) sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Perlite: Horticultural perlite, soil amendment grade.

E. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through a No. 50 sieve.

F. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C33/C33M.

2.3 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance," and as follows:
1. Reaction: pH of 5.5 to 8.
2. Soluble-Salt Concentration: Less than 4 dS/m.
3. Moisture Content: 35 to 55 percent by weight.
4. Organic-Matter Content: 30 to 40 percent of dry weight.
5. Particle Size: Minimum of 98 percent passing through a 2-inch sieve.

2.4 FERTILIZERS

A. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

PART 3 - EXECUTION

3.1 GENERAL

A. Place planting soil and fertilizers according to requirements in other Specification Sections.

B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.

C. Proceed with placement only after unsatisfactory conditions have been corrected.

3.2 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

A. Unacceptable Materials: Clean soil of concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.

B. Unsuitable Materials: Clean soil to contain a maximum of 5 percent by dry weight of stones, roots, plants, sod, clay lumps, and pockets of coarse sand.

C. Screening: Pass unamended soil through a 3-inch sieve to remove large materials.

3.3 PLACING AND MIXING PLANTING SOIL OVER EXPOSED SUBGRADE

A. General: Apply and mix unamended soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Subgrade Preparation: Till subgrade to a minimum depth of 4 inches. Remove stones larger than 2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply approximately half the thickness of planting soil over prepared, loosened subgrade. Mix thoroughly with tilled subgrade. Spread remainder of planting soil.

C. Application: Spread planting soil to total depth indicated on Drawings, but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.

1. Lifts: Apply and mix unamended soil and amendments in lifts not exceeding 6 inches in loose depth for material compacted by compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

D. Compaction: Compact each blended lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D698 and tested in-place.

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.4 PLACING MANUFACTURED PLANTING SOIL OVER EXPOSED SUBGRADE

A. General: Apply manufactured soil on-site in its final, blended condition. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Subgrade Preparation: Till subgrade to a minimum depth of 6 inches. Remove stones larger than 2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply approximately half the thickness of planting soil over prepared, loosened subgrade. Mix thoroughly into top 2 inches of subgrade. Spread remainder of planting soil.

C. Application: Spread planting soil to total depth indicated on Drawings, but not less than required to meet finish grades after natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.

1. Lifts: Apply planting soil in lifts not exceeding 6 inches in loose depth for material compacted by compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

D. Compaction: Compact each lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D698.

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.5 APPLYING COMPOST TO SURFACE OF PLANTING SOIL

A. Application: Apply 4 inches to surface of in-place planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Finish Grading: Grade surface to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.6 LAYERED SOIL ASSEMBLIES

A. Layered Soil Assembly Type 1:

1. Top Layer: Planting-soil Type 2.

2. Layers Below: Planting-soil types to be determined in coordination with recommendations from the geotechnical report.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections:

1. Compaction: Test planting-soil compaction after placing each lift and at completion using a densitometer or soil-compaction meter calibrated to a reference test value based on laboratory testing according to ASTM D698. Space tests at no less than one for each 1000 sq. ft. of in-place soil or part thereof.

C. Soil will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Label each sample and test report with the date, location keyed to a site plan or other location system, visible conditions when and where sample was taken, and sampling depth.

3.8 PROTECTION

A. Protection Zone: Identify protection zones according to Section 015639 "Temporary Tree and Plant Protection."

B. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Vehicle traffic.
4. Foot traffic.
5. Erection of sheds or structures.
6. Impoundment of water.
7. Excavation or other digging unless otherwise indicated.

C. If planting soil or subgrade is overcompacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade as directed by Architect and replace contaminated planting soil with new planting soil.

3.9 CLEANING

A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.

B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.

1. Dispose of excess subsoil and unsuitable materials on-site where directed by Owner.

END OF SECTION 329113

SECTION 329200 - TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Seeding.
2. Hydroseeding.
3. Sodding.
4. Plugging.
5. Erosion-control materials.

B. Related Requirements:

1. Section 329300 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings and mow strips.

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation" and drawing designations for planting soils.

E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

1. Certification of each seed mixture for turfgrass sod. Include identification of source and name and telephone number of supplier.

C. Product Certificates: For fertilizers, from manufacturer.

D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required maintenance periods.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.

1. Professional Membership: Installer shall be a member in good standing of either the National Association of Landscape Professionals or AmericanHort.
2. Experience: Five years' experience in turf installation in addition to requirements in Section 014000 "Quality Requirements."
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
4. Personnel Certifications: Installer's field supervisor shall have certification in one or all of the following categories from the National Association of Landscape Professionals:

    a. Landscape Industry Certified Technician - Exterior.
    b. Landscape Industry Certified Lawn Care Manager.
    c. Landscape Industry Certified Lawn Care Technician.

5. Pesticide Applicator: State licensed, commercial.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.

C. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

1.9 FIELD CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.

1. Grass Species: Coordinate planting period with seed supplier.
2. All Other Species:
   a. Spring Planting: April-May.
   b. Fall Planting: October-November.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species:

1. Quality, State Certified: State-certified seed of grass species as listed below for solar exposure.

2. Full Sun, Warm-Season Grass: Bermudagrass (Cynodon dactylon).

2.2 TURFGRASS SOD

A. Turfgrass Sod: Certified, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture that is strongly rooted and capable of vigorous growth and development when planted.

B. Turfgrass Species, Warm-Season Grass: Bermudagrass (Cynodon dactylon). To be approved by Owner and Landscape Architect.

2.3 PLUGS

A. Plugs: Turfgrass sod, Certified, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture that is cut into square or round plugs, strongly rooted, and capable of vigorous growth and development when planted; of the following turfgrass species and plug size:

1. Turfgrass Species: Bermudagrass (Cynodon dactylon).
2. Plug Size: 2 inches.

2.4 FERTILIZERS

A. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition:

a. 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.

2.5 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

2.6 PESTICIDES

A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.7 EROSION-CONTROL MATERIALS

A. Erosion-Control Fiber Mesh: Biodegradable burlap, a minimum of 0.92 lb/sq. yd., with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
3. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
2. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."

B. Placing Planting Soil: Place and mix planting soil in place over exposed subgrade.

1. Reduce elevation of planting soil to allow for soil thickness of sod.

C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

D. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

A. Prepare area as specified in "Turf Area Preparation" Article.

B. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.

C. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.5 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.

1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
2. Do not use wet seed or seed that is moldy or otherwise damaged.
3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

B. Sow seed at a total rate of 2 lb/1000 sq. ft.

C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

D. Protect seeded areas with erosion-control fiber mesh where indicated on Drawings; install and anchor according to manufacturer's written instructions.

E. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.

1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.

F. Protect seeded areas from hot, dry weather or drying winds by applying planting soil within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch, and roll surface smooth.

3.6 HYDROSEEDING

A. Hydroseeding: Mix specified seed and fiber mulch in water, using equipment specifically designed for hydroseed application and free of unwanted weeds and seeds. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

1. Mix slurry with tackifier.
2. Spray-apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.

3.7 SODDING

A. Lay sod within 24 hours of harvesting unless a suitable preservation method is accepted by Landscape Architect prior to delivery time. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to soil or sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

1. Lay sod across slopes exceeding 1:3.

C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.8 PLUGGING

A. Plant plugs in holes or furrows, spaced 12 inches apart in triangular pattern. On slopes, contour furrows to near level.

3.9 TURF MAINTENANCE

A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy,

viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
1. Mow bermudagrass to a height of 1/2 to 1 inch.

D. Turf Postfertilization: Apply slow-release fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that provides actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.10 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Landscape Architect:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
3. Satisfactory Plugged Turf: At end of maintenance period, the required number of plugs has been established as well-rooted, viable patches of grass, and areas between plugs are free of weeds and other undesirable vegetation.

4. Satisfactory Sprigged Turf: At end of maintenance period, the required number of sprigs has been established as well-rooted, viable plants, and areas between sprigs are free of weeds and other undesirable vegetation.

B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

3.11 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.12 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

3.13 MAINTENANCE SERVICE

A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:

1. Seeded Turf: 12 months from date of Final Acceptance.

    a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

2. Sodded Turf: 12 months from date of Final Acceptance.
3. Plugged Turf: 12 months from date of Final Acceptance.

END OF SECTION 329200

SECTION 329300 - PLANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plant materials.
2. Fertilizers.
3. Weed-control barriers.
4. Mulches.
5. Herbicides and pesticides.
6. Tree-stabilization materials.
7. Landscape edgings.
8. Tree-watering devices.

B. Related Requirements:

1. Section 015639 "Temporary Tree and Plant Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
2. Section 329200 "Turf and Grasses" for turf (lawn) and meadow planting, hydroseeding, and erosion-control materials.

1.2 COORDINATION

A. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.

1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Plant materials.
2. Fertilizers.
3. Weed-control barriers.
4. Mulches.

5. Herbicides and pesticides.
6. Tree-stabilization materials.
7. Landscape edgings.
8. Tree-watering devices.

B. Product Data Submittals: For each product.

1. Plant Materials: Include quantities, sizes, quality, and verified sources for plant materials.

C. Samples for Verification: Actual sample of finished products for each of the following:

1. Organic Mulch: 1-pint volume of each organic mulch required; typical of the lot of material to be furnished, in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Provide an accurate representation of color, texture, and organic makeup.
2. Weed-Control Barrier: 12 by 12 inches.
3. Proprietary Root-Ball-Stabilization Device: One unit.
4. Slow-Release, Tree-Watering Device: One unit of each size required.
5. Edging Materials and Accessories: Manufacturer's standard size, to verify color selected.
6. Root Barrier: Width of panel by 12 inches.

1.5 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Reports: Percolation tests for tree pits. Include the following:

1. Tree identification number matching the plans.
2. Date of test.
3. Time when water was added to tree pit to start percolation test.
4. Time with photo documentation showing increments of testing with water level in tree pit.
5. Identification of tester.

B. Qualification Statements: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.

C. Product Certificates: For each type of manufactured product, from manufacturer, and complying with manufacturer's certified analysis of standard products.

D. Pesticides and Herbicides: Product label and manufacturer's written application instructions specific to Project.

E. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.

1. Professional Membership: Member in good standing of either the National Association of Landscape Professionals or AmericanHort.
2. Experience: Five years' experience in landscape installation in addition to requirements in Section 014000 "Quality Requirements."
3. Installer's Field Supervision: Maintain an experienced full-time supervisor on Project site when work is in progress.
4. Personnel Certification: Installer's field supervisor certified in all of the following categories from the National Association of Landscape Professionals:

    a. Landscape Industry Certified Technician - Exterior.
    b. Landscape Industry Certified Horticultural Technician.

5. Pesticide Applicator: State licensed, commercial.

B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

1. Selection of plants purchased under allowances is made by Landscape Architect, who tags plants at their place of growth before they are prepared for transplanting.

2. All plants to be labeled with genus, species, variety, and size.

C. Measurements: Measure in accordance with ANSI Z60.1. Do not prune to obtain required sizes.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.
2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

D. Plant Material Observation: Landscape Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Landscape Architect may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective

material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1. Notify Landscape Architect of sources of planting materials seven days in advance of delivery to site.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, or walkways and pavements; or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

C. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

D. Handle planting stock by root ball.

E. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F until planting.

F. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.

1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.

G. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

H. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
2. Do not remove container-grown stock from containers before time of planting.

3. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

1. Spring Planting: April-May.
2. Fall Planting: October-November.

C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions in accordance with manufacturer's written instructions and warranty requirements.

1.10 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
b. Structural failures, including plantings falling or blowing over.
c. Faulty performance of tree stabilization and edgings.
d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Periods: From date of Final Acceptance.

a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.
c. Annuals: Three months.

3. Include the following remedial actions as a minimum:

a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.

c. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.
d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

PART 2 - PRODUCTS

2.1 PLANT MATERIALS

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

1. Trees with damaged, crooked, or multiple leaders; with tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); with crossing trunks; with cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots are unacceptable.
2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.

C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare in accordance with ANSI Z60.1.

D. Labeling: Label each plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for plant.

E. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to ensure symmetry in planting.

F. Annuals and Biennials: Provide healthy, disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery.

2.2 FERTILIZERS

A. Granular Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition:

a. 3 percent of actual nitrogen, 4 percent phosphorous, and 3 percent potassium, by weight.

B. Mycorrhizal Fungi: Dry, granular inoculant containing at least 5300 spores per lb of vesicular-arbuscular mycorrhizal fungi and 95 million spores per lb of ectomycorrhizal fungi, 33 percent hydrogel, and maximum of 5.5 percent inert material.

2.3 WEED-CONTROL BARRIERS

A. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. minimum, composed of fibers inert to biological degradation and naturally resistant to chemicals, alkalis, and acids, formed into a stable network so that fibers retain their relative position.

2.4 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

1. Type: Ground or shredded bark.
2. Size Range: 3 inches maximum, 1/2 inch minimum.
3. Color: Natural.

2.5 HERBICIDES AND PESTICIDES

A. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

B. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

C. Pesticides: Registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended in writing by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

2.6 TREE-STABILIZATION MATERIALS

A. Trunk-Stabilization Materials:

1. Upright Stakes and Horizontal Hold-Down: Rough-sawn, sound, new hardwood or softwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal) by length indicated; stakes pointed at one end.
2. Wood Screws: ASME B18.6.1.

2.7 LANDSCAPE EDGINGS

A. Steel Edging: Standard commercial-steel edging, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.

1. Edging Size: 1/4 inch thick by 8 inches deep.
2. Stakes: Tapered steel, a minimum of 12 inches long.
3. Accessories: Standard tapered ends, corners, and splicers.
4. Finish: Powder-coated.

a. Paint Color: Black.

2.8 TREE-WATERING DEVICES

A. Watering Pipe: PVC pipe 4 inches in diameter, site-cut to length as required, and with snug-fitting removable cap.

B. Slow-Release Watering Device: Standard product manufactured for drip irrigation of plants and emptying its water contents over two to nine hours; manufactured from UV-light-stabilized nylon-reinforced polyethylene sheet, PVC, or HDPE plastic.
1. Color: As selected by Landscape Architect from manufacturer's full range.

2.9 MISCELLANEOUS PRODUCTS

A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix in accordance with manufacturer's written instructions.

B. Planter Drainage Gravel: Washed, sound crushed stone or gravel complying with ASTM D448 for Size No. 8.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
3. Suspend planting operations during periods of excessive soil moisture until moisture content reaches acceptable levels to attain required results.
4. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove soil and contamination as directed by Architect and replace with new planting soil.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Landscape Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.

D. Lay out plants at locations directed by Landscape Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

3.3 PLANTING AREA ESTABLISHMENT

A. General: Prepare planting area for soil placement and mix planting soil in accordance with Section 329113 "Soil Preparation."

B. Placing Planting Soil: Place and mix planting soil in-place over exposed subgrade.

C. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

D. Application of Mycorrhizal Fungi: At time directed by Landscape Architect, broadcast dry product uniformly over prepared soil at application rate in accordance with manufacturer's written instructions.

3.4 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits.

1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
2. Excavate approximately three times as wide as ball diameter for balled and burlapped stock.
3. Do not excavate deeper than depth of root ball, measured from the root flare to the bottom of root ball.
4. If area under the plant was initially dug too deep, add soil to raise it to correct level and thoroughly tamp the added soil to prevent settling.
5. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
6. Maintain supervision of excavations during working hours.
7. Keep excavations covered or otherwise protected when unattended by Installer's personnel.
8. If drain tile is indicated on Drawings or required under planting areas, excavate to top of porous backfill over tile.

B. Backfill Soil: Subsoil and topsoil removed from excavations may be used as backfill soil unless otherwise indicated.

C. Obstructions: Notify Landscape Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

1. Hardpan Layer: Drill 6-inch-diameter holes, 24 inches apart, into free-draining strata or to depth of 10 ft., whichever is less, and backfill with free-draining material.

D. Drainage: Notify Landscape Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.5 TREE AND SHRUB PLANTING

A. Inspection: At time of planting, verify that root flare is visible at top of root ball in accordance with ANSI Z60.1. If root flare is not visible, remove soil in a level manner from root ball to where the top-most root emerges from the trunk. After soil removal to expose root flare, verify that root ball still meets size requirements.

B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.

1. Backfill: Planting soil. For trees, use excavated soil for backfill.
2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Continue backfilling process. Water again after placing and tamping final layer of soil.

D. Container-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.

1. Backfill: Planting soil.
2. Carefully remove root ball from container without damaging root ball or plant.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Distribute granular fertilizer around each planting pit when pit is approximately one-half filled. Do not place in bottom of the hole.
5. Continue backfilling process. Water again after placing and tamping final layer of soil.

E. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of root ball.

3.6 TREE AND SHRUB PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Do not apply pruning paint to wounds.

3.7 INSTALLATION OF TREE-STABILIZATION MATERIALS

A. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as follows unless otherwise indicated:

1. Site-Fabricated, Staking-and-Guying Method: Install no fewer than three guys spaced equally around tree.

a. Securely attach guys to stakes 30 inches long, driven to grade. Adjust spacing to avoid penetrating root balls or root masses. Provide turnbuckle for each guy wire and tighten securely.
b. Support trees with guy cable, connected to brass grommets of tree-tie webbing at contact points with tree trunk and reaching to turnbuckle. Allow enough slack to avoid rigid restraint of tree.

2. Proprietary Staking and Guying Device: Install staking and guying system sized and positioned as recommended by manufacturer unless otherwise indicated and in accordance with manufacturer's written instructions.

3.8 PLACING SOIL IN PLANTERS

A. Place a layer of drainage gravel at least 4 inches thick in bottom of planter. Cover bottom with filter fabric and wrap filter fabric 4 inches up on all sides. Duct tape along the entire top edge of filter fabric, to secure filter fabric against the sides during soil-filling process.

B. Fill planter with planting soil. Place soil in lightly compacted layers to elevation of 1-1/2 inches below top of planter, allowing natural settlement.

3.9 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing.

B. Use planting soil for backfill.

C. Dig holes large enough to allow spreading of roots.

D. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to depth not less than two nodes.

E. Work soil around roots to eliminate air pockets and leave slight saucer indentation around plants to hold water.

F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.10 INSTALLATION OF MULCHES

A. Install weed-control barriers before mulching in accordance with manufacturer's written instructions. Completely cover area to be mulched, overlapping edges minimum of 6 inches, and secure seams with galvanized pins.

B. Mulch backfilled surfaces of planting areas and other areas indicated.

1. Organic Mulch in Planting Areas: Apply 2-inch average thickness of organic mulch extending 12 inches beyond edge of individual planting pit or trench and over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.

3.11 INSTALLATION OF LANDSCAPE EDGINGS

A. Steel Edging: Install steel edging where indicated in accordance with manufacturer's written instructions. Anchor with steel stakes spaced approximately 30 inches apart, driven below top elevation of edging.

B. Shovel-Cut Edging: Separate mulched areas from turf areas, curbs, and paving with 45-degree, 4- to 6-inch-deep, shovel-cut edge as indicated on Drawings.

3.12 INSTALLATION OF TREE-WATERING DEVICES

A. Provide one device for each tree.

B. Place device on top of the mulch at base of tree stem and fill with water in accordance with manufacturer's written instructions.

3.13 APPLICATION OF HERBICIDES AND PESTICIDES

A. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas in accordance with manufacturer's written instructions. Do not apply to seeded areas.

B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written instructions.

C. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and in accordance with manufacturer's written instructions. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

3.14 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.

B. Install and maintain temporary piping, hoses, and plant-watering equipment to convey water from sources and to keep plants uniformly moist during establishment.

C. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

D. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.15 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Perform tree pit percolation tests.
2. Tree pit construction will be considered defective if it does not pass percolation tests and inspections.
3. Do not proceed with planting in tree pits until satisfactory percolation is demonstrated.

C. Prepare test and inspection reports.

3.16 REPAIR AND REPLACEMENT

A. Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Architect.

1. Submit details of proposed pruning and repairs.
2. Perform repairs of branches and roots within 24 hours, if approved.
3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Landscape Architect.

B. Remove and replace trees that are more than 25 percent dead or in unhealthy condition or are damaged during construction operations that Landscape Architect determines are incapable of restoring to normal growth pattern.

3.17 CLEANING AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

D. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

E. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

END OF SECTION 329300

SECTION 330600 - FACILITY WATER DISTRIBUTION PIPING

GENERAL

RELATED DOCUMENTS

a. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

b. Materials and installation shall be in accordance with City of Raleigh Public Utilities Handbook and Standard Details.

SUMMARY

c. This Section includes water-distribution piping and related components outside the building for water service and fire-service mains.

a. Utility-furnished products include water meters that will be furnished to the site, ready for installation.

DEFINITIONS

a. DI: Ductile Iron.

SUBMITTALS

b. Product Data: For each type of product indicated.

c. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.

a. Field quality-control test reports.

b. Operation and Maintenance Data: For water valves and specialties to include in emergency, operation, and maintenance manuals.

QUALITY ASSURANCE

a. Regulatory Requirements:

1) Comply with requirements of City of Raleigh supplying water. Include tapping of water mains and backflow prevention.
2) Comply with standards of City of Raleigh for potable-water-service and reclaim water service piping, including materials, installation, testing, and disinfection.

3) Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

b. Piping materials shall bear label, stamp, or other markings of specified testing agency.

c. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

d. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.

e. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

f. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.

g. NSF Compliance:

1) Comply with NSF 14 for plastic potable-water-service piping. Include marking "NSF-pw" on piping.
2) Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

DELIVERY, STORAGE, AND HANDLING

b. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:

1) Ensure that valves are dry and internally protected against rust and corrosion.
2) Protect valves against damage to threaded ends and flange faces.
3) Set valves in best position for handling. Set valves closed to prevent rattling.

c. During Storage: Use precautions for valves, including fire hydrants, according to the following:

1) Do not remove end protectors unless necessary for inspection; then reinstall for storage.
2) Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

d. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

e. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

f. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

g. Protect flanges, fittings, and specialties from moisture and dirt.

h. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

PROJECT CONDITIONS

a. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:

1) Notify Construction Manager and Owner no fewer than two days in advance of proposed interruption of service.
2) Do not proceed with interruption of water-distribution service without Construction Manager's and Owner's written permission.

COORDINATION

a. Coordinate connection to water main with utility company.

PRODUCTS

DUCTILE-IRON PIPE AND FITTINGS

a. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated. Ductile iron pipes and fittings shall be in accordance with local governing authority water material standards.

1) Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2) Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

a. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.

1) Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2) Gaskets: AWWA C111, rubber.

b. Grooved-Joint, Ductile-Iron Pipe: AWWA C151, with cut, rounded-grooved ends.

1) Grooved-End, Ductile-Iron Pipe Appurtenances:

a) Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
b) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

(1) Anvil International, Inc.
(2) Victaulic Company of America.

a) Grooved-End, Ductile-Iron Fittings: ASTM A 47, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.
b) Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

a. Flanges: ASME 16.1, Class 125, cast iron.

JOINING MATERIALS (NOT USED)

CORROSION-PROTECTION PIPING ENCASEMENT

b. Encasement for Underground Metal Piping:

1) Standards: ASTM A 674, AWWA C105, local governing authority water material standards.
2) Form: Sheet or tube.
1) Material: LLDPE film of 0.008-inch minimum thickness.
2) Material: LLDPE film of 0.008-inch minimum thickness, or high-density, crosslaminated PE film of 0.004-inch minimum thickness.
3) Material: High-density, crosslaminated PE film of 0.004-inch minimum thickness.
4) Color: Black.

GATE VALVES

b. AWWA, Cast-Iron Gate Valves:

1) Standards: ASTM A 674, AWWA C105, C-509-94, C515, local governing authority water material standards.

2) Available Manufacturers: Subject to compliance with requirements of local governing authority. Manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a) American AVK Co.; Valves & Fittings Div.
b) American Cast Iron Pipe Co.; American Flow Control Div.
c) American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
d) McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
e) McWane, Inc.; Kennedy Valve Div.
f) McWane, Inc.; M & H Valve Company Div.
g) Mueller Co.; Water Products Div.

1) Nonrising-Stem, Resilient-Seated Gate Valves:

a) Description: Gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.

(3) Standard: AWWA C509.
(4) Minimum Pressure Rating: 200 psig.
(5) End Connections: Mechanical joint.
(6) Interior Coating: Complying with AWWA C550.

2) Nonrising-Stem, High-Pressure, Resilient-Seated Gate Valves:

a) Description: Ductile-iron body and bonnet; with bronze or ductile-iron gate, resilient seats, bronze stem, and stem nut.

(7) Standard: AWWA C509.
(8) Minimum Pressure Rating: 250 psig.
(9) End Connections: Push on or mechanical joint.
(10) Interior Coating: Complying with AWWA C550.

3) OS&Y, Rising-Stem, Resilient-Seated Gate Valves:

a) Description: Cast- or ductile-iron body and bonnet, with bronze or gray- or ductile-iron gate, resilient seats, and bronze stem.

(11) Standard: AWWA C509.
(12) Minimum Pressure Rating: 200 psig.
(13) End Connections: Flanged.

GATE VALVE ACCESSORIES AND SPECIALTIES

a. Tapping-Sleeve Assemblies:

1) Standards: AWWA C-110-98, local governing authority water material standards:
2) Available Manufacturers: Subject to compliance with requirements of local governing authority water material standards. Manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a) American Pipe Company
b) Rockwell
c) Romac
d) Ford
e) JCM
f) Clow Valve Co. Div. (Oskaloosa).
g) Kennedy Valve Div.
h) Mueller Co.; Water Products Div.
i) U.S. Pipe and Foundry Company.

3) Description: Sleeve and valve compatible with drilling machine.

a) Standard: MSS SP-60 and local governing authority water material standards.

b) Tapping Sleeve: Cast- or ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
c) Valve: AWWA, cast-iron, nonrising-stem, resilient-seated gate valve with one raised face flange mating tapping-sleeve flange.

b. Valve Boxes: Comply with ASTM A48 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches in diameter. All castings must be domestically cast and so indicated by the manufacturer's name and "USA" cast into all section of the valve box. All castings must meet or exceed AASHTO H-20 load rating. Total valve box weight shall be of 85 lbs. minimum and have minimum lid weight of 25 lbs.

1) Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

c. Indicator Posts: UL 789, FMG-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

CHECK VALVES (NOT USED)

DETECTOR CHECK VALVES

a. Detector Check Valves:

1) Standards: Local governing authority water material standards.
2) Available Manufacturers: Subject to compliance with requirements of City of Raleigh water material standards. Manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a) Ames Fire & Waterworks; a division of Watts Regulator Co.
b) FEBCO
c) Conbraco
d) Watts Water Technologies, Inc.
e) Wilkins

1) Description: Galvanized cast-iron body, bolted cover with air-bleed device for access to internal parts, and flanged ends. Include one-piece bronze disc with bronze bushings, pivot, and replaceable seat. Include threaded bypass taps in inlet and outlet for bypass meter connection. Set valve to allow minimal water flow through bypass meter when major water flow is required.

a) Standards: UL 312 and FMG approved.
b) Pressure Rating: 175 psig.
c) Water Meter: AWWA C700, disc type, at least one-fourth size of detector check valve. Include meter, bypass piping, gate valves, check valve, and connections to detector check valve.

1) Description: Iron body, corrosion-resistant clapper ring and seat ring material, flanged ends, with connections for bypass and installation of water meter.

a) Standards: UL 312 and FMG approved.
b) Pressure Rating: 175 psig.

BUTTERFLY VALVES (NOT USED)

PLUG VALVES (NOT USED)

CORPORATION VALVES AND CURB VALVES

b. Manufacturers:

1) Standards: Shall conform to local governing authority water material standards.
2) Available Manufacturers: Subject to compliance with requirements of local governing authority water material standards. Manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a) Ford Meter Box Company, Inc. (The); Pipe Products Div.
b) McDonald, A. Y. Mfg. Co.
c) Mueller Co.; Water Products Div.
d) Oniseal
e) Hayes NuSeal

b. Curb Valves: Comply with AWWA C800. Include bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.

c. Service Boxes for Curb Valves: Similar to ASTM A48 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over curb valve and with a barrel approximately 5 inches in diameter. All castings must be domestically cast and so indicated by the manufacturer’s name and “USA” cast into all section of the valve box. All castings must meet or exceed AASHTO H-20 load rating. Total valve box weight shall be of 85 lbs. minimum and have minimum lid weight of 25 lbs

1) Shutoff Rods: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.

WATER METERS

d. Existing water meter to be turned into the City of Raleigh.

e. Domestic and Irrigation water meters will be purchased from the City of Raleigh.

RELIEF VALVES (NOT USED)

BACKFLOW PREVENTERS

a. Reduced-Pressure-Principle Backflow Preventers:

1) Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings and approved for use by the City of Raleigh by one of the following:

a) Ames Fire & Waterworks; a division of Watts Regulator Co.
b) Conbraco Industries, Inc.
c) FEBCO; SPX Valves & Controls.
d) Flomatic Corporation.
e) Watts Water Technologies, Inc.
f) Wilkins; a Zurn company.

2) Accessories:

a) Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; OS&Y gate type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
b) Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.
c) Tamper switch.

PROTECTIVE ENCLOSURES

b. Freeze-Protection Enclosures:

1) Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:

a) Aqua Shield.
b) BF Products, Inc.
c) DekoRRa Products.
d) Dunco Manufacturing, Inc.
e) G&C Enclosures.
f) Hot Box, Inc.
g) HydroCowl, Inc.
h) Watts Water Technologies, Inc.

2) Description: Insulated enclosure designed to protect aboveground water piping, equipment, or specialties from freezing and damage, with heat source to maintain minimum internal temperature of 40 deg F when external temperatures reach as low as minus 34 deg F.

a) Standard: ASSE 1060.
a) Class I: For equipment or devices other than pressure or atmospheric vacuum breakers.

b) Class I-V: For pressure or atmospheric vacuum breaker equipment or devices. Include drain opening in housing.

(14) Housing: Reinforced aluminum or fiberglass construction per the Wake Technical College Project Manager direction.

(a) Size: Of dimensions indicated, but not less than those required for access and service of protected unit.
(b) Drain opening for units with drain connection.
(c) Access doors with locking devices.
(d) Insulation inside housing.
(e) Anchoring devices for attaching housing to concrete base.

(15) Electric heating cable or heater with self-limiting temperature control.

a. Enclosure Bases:

1) Description: 6-inch minimum thickness precast concrete, of dimensions required to extend at least 6 inches beyond edges of enclosure housings. Include openings for piping.

FIRE HYDRANTS

a. Dry-Barrel Fire Hydrants:

1) Available Manufacturers: Subject to compliance with requirements of the City of Raleigh. Manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a) American AVK Co.; Valves & Fittings Div.
b) American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
c) American Foundry Group, Inc.
d) East Jordan Iron Works, Inc.
e) McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
f) McWane, Inc.; Kennedy Valve Div.
g) McWane, Inc.; M & H Valve Company Div.
h) Mueller Co.; Water Products Div.
i) U.S. Pipe and Foundry Company.

1) Description: Freestanding, two-2 ½" nozzles and 1-5" Storz connection nozzle. The nozzle shall be an integral part of the fire haydrant and must be furnished by the manufacturer or authorized distributor designated by the manufacturer. Storz connector shall have the following characteristics: brass hydrant nozzle connection; have hard anodized aluminum Storz ramps and lugs (hydrant and cap side); and require high-torque Storz spanner wrench in order for cap to be removed. All nozzles shall be provided with cap to cap retaining chain. The hydrant valve opening shall be 5 ¼". Bronze to bronze threads shall be between hydrant seat or seat ring and the seating attaching assembly. All hydrants must include cast or ductile epoxy lined shoe, rubber drain seals and positive, protective valve stop device. Hydrants shall be open-left type and shall have 6" hub-end

or mechanical joint elbow. The hydrant barrel shall be of sufficient length to provide a minimum of 3.5’ of bury and be break-away impact type.

a) Standard: AWWA C502.
b) Pressure Rating: 150 psig minimum.
a) Operating and Cap Nuts: Pentagon, 1-1/2 inches point to flat.
b) Direction of Opening: Open hydrant valve by turning operating nut to left or counterclockwise.
c) Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.

FIRE DEPARTMENT CONNECTIONS (NOT USED)

ALARM DEVICES

b. Alarm Devices, General: UL 753 and FMG approved, of types and sizes to mate and match piping and equipment.

a. Supervisory Switches: Single pole, double throw; designed to signal valve in other than fully open position.

a. Pressure Switches: Single pole, double throw; designed to signal increase in pressure.

EXECUTION

EARTHWORK

a. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

PIPING APPLICATIONS

a. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.

b. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.

c. Do not use flanges or unions for underground piping.

d. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.

a. Underground water-service piping NPS 3/4 to NPS 2 shall be the following:

1) Soft copper tube, ASTM B 88, Type K; copper, pressure-seal fittings; and pressure-sealed joints.

a. Underground water-service piping NPS 2 1/2 and greater shall be of the following:

1) Ductile-iron, push-on-joint pipe or mechanical-joint pipe joints.

VALVE APPLICATIONS

a. General Application: Use mechanical-joint-end valves for NPS 2 1/2 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 and smaller installation.

b. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1) Underground Valves, NPS 3 and Larger: AWWA, cast-iron, nonrising-stem, resilient-seated gate valves with valve box.
2) Underground Valves, NPS 4 and Larger, for Indicator Posts: UL/FMG, cast-iron, nonrising-stem gate valves with indicator post.

PIPING SYSTEMS - COMMON REQUIREMENTS (NOT USED)

PIPING INSTALLATION

b. Water-Main Connection: Arrange with utility company for tap of size and in location indicated in water main.

a. Water-Main Connection: Tap water main according to requirements of water utility company and of size and in location indicated.

a. Make connections larger than NPS 2 with tapping machine according to the following:

1) Install tapping sleeve and tapping valve according to MSS SP-60.
2) Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
3) Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
4) Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.

a. Comply with NFPA 24 for fire-service-main piping materials and installation.

1) Install PE corrosion-protection encasement according to ASTM A 674 or AWWA C105.

b. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.

1) Install PE corrosion-protection encasement according to ASTM A 674 or AWWA C105.

a. Bury piping with depth of cover over top at least 36 inches.

b. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.

c. Sleeves are specified in Division 22 Section "Common Work Results for Plumbing."

d. Mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."

a. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

JOINT CONSTRUCTION

b. See Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.

c. Make pipe joints according to the following:
   1) Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
   2) Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
   3) Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure. Refer to Division 22 Section "Common Work Results for Plumbing" for joining piping of dissimilar metals.

ANCHORAGE INSTALLATION

a. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:

   1) Concrete thrust blocks.
   2) Locking mechanical joints.
   3) Set-screw mechanical retainer glands.
   4) Bolted flanged joints.
   5) Pipe clamps and tie rods.

b. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:

   1) Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
   2) Fire-Service-Main Piping: According to NFPA 24.

c. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

VALVE INSTALLATION

d. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

e. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.

f. UL/FMG, Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.

g. UL/FMG, Valves Other Than Gate Valves: Comply with NFPA 24.

h. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.

i. Relief Valves: Comply with AWWA C512. Install aboveground with shutoff valve on inlet.

FIRE HYDRANT INSTALLATION

j. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.

k. AWWA Fire Hydrants: Comply with AWWA M17.

l. UL/FMG Fire Hydrants: Comply with NFPA 24.

FLUSHING HYDRANT INSTALLATION (NOT USED)

FIRE DEPARTMENT CONNECTION INSTALLATION (NOT USED)

ALARM DEVICE INSTALLATION

m. General: Comply with NFPA 24 for devices and methods of valve supervision. Underground valves with valve box do not require supervision.

n. Supervisory Switches: Supervise valves in open position.

1) Valves: Grind away portion of exposed valve stem. Bolt switch, with plunger in stem depression, to OS&Y gate-valve yoke.
2) Indicator Posts: Drill and thread hole in upper-barrel section at target plate. Install switch, with toggle against target plate, on barrel of indicator post.

a. Locking and Sealing: Secure unsupervised valves as follows:

1) Valves: Install chain and padlock on open OS&Y gate valve.
2) Post Indicators: Install padlock on wrench on indicator post.

b. Pressure Switches: Drill and thread hole in exposed barrel of fire hydrant. Install switch.

c. Water-Flow Indicators: Install in water-service piping in vault. Select indicator with saddle and vane matching pipe size. Drill hole in pipe, insert vane, and bolt saddle to pipe.

d. Connect alarm devices to building fire alarm system. Wiring and fire-alarm devices are specified in Division 28 Section "Fire Detection and Alarm."

CONNECTIONS

a. Drawings indicate general arrangement of piping, fittings, and specialties.

b. Connect water-distribution piping to water main with tee and valve.

FIELD QUALITY CONTROL

c. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. City of Raleigh shall inspect all concrete thrust blocks. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

d. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.

1) Coordinate with City of Raleigh Inspections.
2) Test shall meet the requirements of the City of Raleigh and NFPA 24.
3) Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig. Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

e. Prepare reports of testing activities.

IDENTIFICATION

f. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of blue warning tape directly over piping and at outside edges of underground valves.

1) Use identification tape or non-detectable warning tape over all underground lines outside building footprint in the backfill approximately 18” to 30” above the service pipe, but a minimum of 10” and a maximum of 24” below finished grade.
2) Use detectable warning tape over ferrous and nonferrous piping and over edges of underground valves. Tape all underground lines outside building footprint directly on top of the pipeline and permanently secured to the pipeline at 10’ intervals.
3) Use insulated copper tracer wire or other approved conductor installed adjacent to underground nonmetallic piping and metallic pipe with compression gasket fittings installed underground. Access shall be provided to the tracer wire or the tracer wire shall terminate aboveground at the end of the nonmetallic piping. The tracer wire size shall not be less than 10AWG and the insulation type suitable for direct burial. The tracer wire size shall be copper single-conductor 10AWG minimum and the insulation type suitable for direct burial with type “UF” (Underground Feeder) insulation and shall be continuous along the pipeline passing through the inside of each valve box or manhole.

a. Permanently attach equipment nameplate or marker indicating plastic water-service piping, on main electrical meter panel. See Division 22 Section "Common Work Results for Plumbing" for identifying devices.

CLEANING

a. Clean and disinfect water-distribution piping as follows:

1) Coordinate with the City of Raleigh Inspections.
2) Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
1) Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.
1) Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:

a) Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
a) Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
b) After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
c) Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

b. Prepare reports of purging and disinfecting activities.

PART 85 - END OF SECTION 330600

SECTION 330700 - FACILITY SANITARY SEWERS

GENERAL

RELATED DOCUMENTS

a. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

b. Materials and Installation shall be in accordance with City of Raleigh Public Utilities Handbook and Standard Details.

SUMMARY

c. Section Includes:

1) Pipe and fittings.
2) Nonpressure and pressure couplings.
3) Expansion joints and deflection fittings.
4) Cleanouts.
5) Encasement for piping.
6) Manholes.

DEFINITIONS

a. DI: Ductile Iron

b. PVC: Polyvinyl Chloride

SUBMITTALS

a. Product Data: For the following:

1) Expansion joints and deflection fittings.

b. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

a. Field quality-control reports.

DELIVERY, STORAGE, AND HANDLING

a. Do not store plastic pipe and fittings in direct sunlight.

b. Protect pipe, pipe fittings, and seals from dirt and damage.

c. Handle manholes according to manufacturer's written rigging instructions.

PROJECT CONDITIONS

a. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1) Notify Construction Manager and Owner no fewer than two days in advance of proposed interruption of service.
2) Do not proceed with interruption of service without Construction Manager's and Owner's written permission.

PRODUCTS

DUCTILE-IRON, GRAVITY SEWER PIPE AND FITTINGS

a. Pipe: AWWA C-150ASTM A 746, for push-on joints. The minimum pressure class shall be class 250.

b. Joints: AWWA C-111-95

a. Standard Fittings: AWWA C110, for push-on joints.

a. Gaskets: AWWA C111, rubber.

b. Lining: Amine cured novalac ceramic epoxy containing at least 20% by volume of ceramic quarts pigments per local governing authority.

PVC PIPE AND FITTINGS

a. PVC Type PSM Sewer Piping:

1) Pipe: ASTM D 3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
2) Fittings: ASTM D 3034, PVC with bell ends.
3) Gaskets: ASTM F 477, elastomeric seals.

CLEANOUTS

a. PVC Cleanouts:

1) Manufacturers: Subject to compliance with requirements of local governing authority. Available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a) Canplas LLC.
   b) IPS Corporation.
   c) NDS.
   d) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
   e) Sioux Chief Manufacturing Company, Inc.
   f) Zurn Light Commercial Products Operation; Zurn Plumbing Products Group.

2) Description: PVC body with bronze slotted plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

MANHOLES

b. Standard Precast Concrete Manholes:

1) Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2) Diameter: 48 inches minimum unless otherwise indicated.
3) Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
4) Base Section: 6-inch minimum thickness for floor slab and 6-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor unless otherwise indicated by local governing authority.
5) Riser Sections: 5-inch minimum thickness, of length to provide depth indicated.
6) Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated; with top of cone of size that matches grade rings.
7) Joint Sealant: ASTM C 990, bitumen or butyl rubber. All exterior joints shall be wrapped for a width of 8-inches.
8) Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
9) Steps: Individual FRP steps; FRP ladder; or ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 15-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 36 inches. Per City of Raleigh Standard Detail S-28.
1) Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
2) Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope. Grade rings to be provided on structures within 12-inches from finished grade unless limited by design or local municipality.
3) Flexible Rubber Pipe Boot: ASTM C923, a flexible rubber boot shall be supplied with the manholes to tie the pipe to the barrel section.

4) Invert Drop: Min. 0.2 feet drop between sanitary sewer pipe invert in to invert out.

b. Designed Precast Concrete Manholes:

1) Description: ASTM C 913; designed according to ASTM C 890 for A-16 (ASSHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.
2) Ballast: Increase thickness of one or more precast concrete sections or add concrete to manhole as required to prevent flotation.
3) Joint Sealant: ASTM C 990, bitumen or butyl rubber.
4) Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
5) Steps: Individual FRP steps; FRP ladder; or ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 15-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 36 inches. Per City of Raleigh Standard Detail S-28.
1) Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
2) Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope. Grade rings to be provided on structures within 12-inches from finished grade unless limited by design or local municipality.
3) Invert Drop: Min. 0.2 feet drop between sanitary sewer pipe invert in to invert out.

b. Manhole Frames and Covers:

1) Description: Ferrous; 22-inch ID by 7- to 9-inch riser, with 4-inch minimum-width flange and 23 1/2-inch diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER." Per City of Raleigh Standard Details S-25 and S-27.
2) Material: ASTM A 536, Grade 60-40-18 ductile iron unless otherwise indicated.

CONCRETE

c. General: Cast-in-place concrete complying with ACI 318, ACI 350/350R, and the following:

1) Cement: ASTM C 150, Type I.
2) Fine Aggregate: ASTM C 33, sand.
3) Coarse Aggregate: ASTM C 33, crushed gravel.
4) Water: Potable.

d. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1) Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.

2) Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

e. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1) Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.

a) Invert Slope: 2 percent through manhole.

2) Benches: Concrete, sloped to drain into channel.

a) Slope: 60 degrees unless indicated otherwise by the local governing authority.

f. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.

1) Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2) Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

EXECUTION

EARTHWORK

g. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

PIPING INSTALLATION

h. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

i. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

j. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

k. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

a. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

b. Install gravity-flow, nonpressure, drainage piping according to the following:

1) Install piping pitched down in direction of flow, at minimum slope of 2 percent unless otherwise indicated.
2) Install ductile-iron, gravity sewer piping according to ASTM A 746.

a. Install corrosion-protection piping encasement over the following underground metal piping according to ASTM A 674 or AWWA C105:

1) Ductile-iron pipe and fittings.
2) Expansion joints and deflection fittings.

b. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

c. Class 1 bedding shall be used where minimum cover in traffic areas is less than 5 feet measured from finished grade to pipe crown.

PIPE JOINT CONSTRUCTION

d. Join gravity-flow, nonpressure, drainage piping according to the following:

1) Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.
2) Join PVC Type PSM sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.

e. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

1) Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.

a) Unshielded flexible couplings for pipes of same or slightly different OD.
b) Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
c) Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

MANHOLE INSTALLATION

f. General: Install manholes complete with appurtenances and accessories indicated.

g. Install precast concrete manhole sections with sealants according to ASTM C 891.

h. Install FRP manholes according to manufacturer's written instructions.

i. Form continuous concrete channels and benches between inlets and outlet.

j. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 12-inches above finished surface elsewhere unless otherwise indicated.

a. Install manhole-cover inserts in frame and immediately below cover.

CONCRETE PLACEMENT

b. Place cast-in-place concrete according to ACI 318.

c. A concrete pad shall be poured between the sanitary sewer and stormwater piping and both lines are to be encased in concrete when the vertical separation of the outside diameters between the two lines is less than 18 inches.

CLEANOUT INSTALLATION

d. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts, and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1) Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
2) Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.

e. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches deep. Set with tops flush with surrounding finished earth grade.

f. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

CONNECTIONS

g. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 22 Section "Sanitary Waste and Vent Piping."

h. Make connections to existing piping and underground manholes.

1) Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch overlap with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
2) Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
3) Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes by cutting opening into existing unit large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering

connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

a) Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
b) Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4) Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

CLOSING ABANDONED SANITARY SEWER SYSTEMS

i. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below or as directed by local governing authority:

1) Close open ends of piping with at least 8-inch thick, brick masonry bulkheads.
2) Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

j. Abandoned Manholes: Excavate around manhole as required and use either procedure below:

1) Remove manhole and close open ends of remaining piping.
2) Remove top of manhole down to at least 48 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

k. Backfill to grade according to Division 31 Section "Earth Moving."

IDENTIFICATION

l. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes. Locate minimum 6” below finished grade, directly over piping.

1) Use detectable warning tape over ferrous piping.
2) Use detectable warning tape over nonferrous piping and over edges of underground manholes.

FIELD QUALITY CONTROL

m. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1) Submit separate report for each system inspection.
2) Defects requiring correction include the following:

a) Alignment: Less than full diameter of inside of pipe is visible between structures.
b) Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
c) Damage: Crushed, broken, cracked, or otherwise damaged piping.
d) Infiltration: Water leakage into piping.
e) Exfiltration: Water leakage from or around piping.

3) Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4) Reinspect and repeat procedure until results are satisfactory.
5) Perform camera review per City of Raleigh requirements.

n. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1) Do not enclose, cover, or put into service before inspection and approval.
2) Test completed piping systems according to requirements of authorities having jurisdiction.
3) Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4) Submit separate report for each test.
1) Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:

a) Fill sewer piping with water. Test with pressure of at least 10-foot head of water, and maintain such pressure without leakage for at least 15 minutes.
b) Close openings in system and fill with water.
c) Purge air and refill with water.
d) Disconnect water supply.
e) Test and inspect joints for leaks.

2) Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:

a) Option: Test plastic gravity sewer piping according to ASTM F 1417.

3) Manholes: Perform hydraulic test according to ASTM C 969.

b. Leaks and loss in test pressure constitute defects that must be repaired.

c. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

CLEANING

d. Clean dirt and superfluous material from interior of piping. Flush with potable water.

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