



Project Manual

Specifications and Other Documents
for

Eastern Wake Site Fire & Rescue Training Center

**Construction Documents – Issue for Construction
March 14th , 2025**

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HH # 22-086

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WTCC EWS - Fire & Rescue Training Center

Wake Technical Community College

HH Project # 22-086

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Site & Civil Architecture

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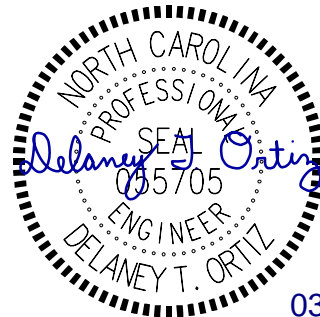
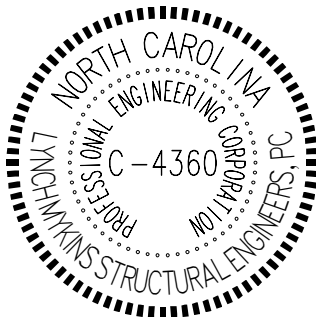
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DIV 01, 21, 22, 23



DIV 26, 27

Fire Training Facility Design

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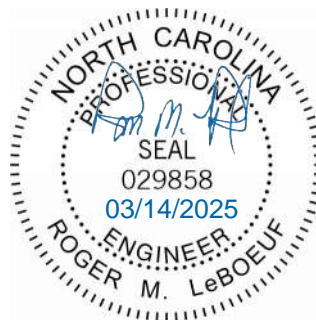


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Wake Tech Community College
5329 Rolesville Road, Wendell, NC 27591

HH # 22-086

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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.

Second Edition January 2013

Revision 1 – May 2024: Article 23.b

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 submittals.
- 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 in 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 losses 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 responsibilities 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.
- c. Applications for payment shall be in a form agreed upon by the CM, designer and Owner and shall be 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 progress, 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.

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 order 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.

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. Paragraph "a": Add the following to the end of the paragraph: "The Geotechnical Technical Report does not constitute part of the Contract Documents but is included for reference."
 - 2. Paragraph "b": Add the following to the end of the paragraph: "The Owner is defined as The Trustees of Wake Technical Community College. Under the Delegation of Authority granted to Wake Technical Community College by the Community College System Office, throughout the General Conditions, replace "the State Construction Office" or "SCO" with "the Owner".
 - 3. 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.
 - 4. Paragraph "dd": Add the following new paragraph: "Latest edition" shall mean the current printed version of the referenced document issued up to 30 calendar days prior to date of receipt of bids, unless specified otherwise.
 - 5. Paragraph "ee": Add the following new paragraph: "Drawings" or "plans" shall mean the drawings enumerated in the contract documents, as well as all the information in the detail manual (when applicable), addenda and designer-prepared field drawings and clarification drawings.
 - 6. Paragraph "ff": Add the following new paragraph: "Specifications" mean this project manual and addenda thereto.
 - 7. Paragraph "gg": Add the following new paragraph: "CM Contingency" shall mean an amount approved by the Owner, to help reduce the risks assumed by the Construction Manager-at-Risk in providing the GMP for the Project. The Owner and the Construction Manager-at-Risk acknowledge that the contingency is included to adjust the estimate for eventualities which have not been taken into precise account in the establishment of the GMP, including:
 - a. Scope gaps between trade contractors (Cause Code SG)
 - b. Contract default by trade contractors (Cause Code CD)
 - c. Unforeseen field conditions (Cause Code UC)
 - d. Design omissions which a prudent Construction Manager-at-Risk could not have reasonably detected during the discharge of his Pre-Construction Services (Cause Code DO)

CM Contingency shall not be used for nonconforming work, replacing/repairing damaged work, designer error. Any unused CM Contingency will be credited back to the Owner on the final change order.

B. Modifications to Article 2 - Intent and Execution of Documents:

1. Paragraph "a": Add the following new sub-paragraphs:

1. "These drawings and specifications represent the general dimensional and aesthetic requirements for various "in place" materials required to produce a building acceptable to the owner for his intended use.
2. It is the intent of these drawings and specifications to provide a building that is structurally sound, water and weather tight, environmentally controllable and conforming to at least the minimum requirements of the North Carolina State Building Code.
3. The Construction Manager ("CM") shall make all reasonable efforts to achieve this intent. If any detail shown on these drawings appears inconsistent with this intent, in the opinion of the CM, he shall notify the Architect in writing of his opinion and await instructions from the Architect before proceeding with the work.
4. Where more detailed information is needed, or when an interpretation of the contract documents is required, the CM shall refer the matter in writing to the designer prior to proceeding with the work. The designer shall furnish the CM an interpretation in writing.
5. If the CM discovers errors, inconsistencies, discrepancies or omissions in the contract documents, the CM shall inform the designer of such condition prior to proceeding with the work.
6. If the CM discovers errors, inconsistencies, discrepancies or omissions in the contract documents prior to bid, the CM shall request clarifications from the designer and shall include in the bid price all work required to deliver a fully operational and ready to use system.
7. If inconsistencies, discrepancies or contradictions in the Contract Documents are discovered after the bid, the CM shall be deemed by submittal of his bid, to have bid the most costly as to labor, materials, duration, sequence and method of construction to provide the work."
8. In all cases noted above, the CM shall copy to the owner on all correspondence.

C. ARTICLE 3 - CLARIFICATION AND DETAIL DRAWINGS

1. **Paragraph "a":** Add the following to the end of the paragraph: "If errors, inconsistencies or discrepancies in the contract documents are discovered by the CM, the CM shall inform the designer and the owner of such condition prior to proceeding with the work. The designer shall furnish the CM written clarification in a reasonable time, so as not to impact the progress of the work."

D. ARTICLE 5 - SHOP DRAWINGS, SUBMITTALS, SAMPLE DATA

1. **Paragraph "c":** Replace "retaining three (3) copies (1, for the Designer, 1 for the owner, and 1 for SCO)" with "retaining an electronic copy and two (2) hard copies of samples (1 for Designer and 1 for the Owner)" Add the following new paragraph: "This schedule must account for any resubmittals required to obtain approval from the Project Designer and Owner."
2. **Paragraph "d":** Add the following new paragraph: "No time extension will be granted for delays caused due to failure of the CM to properly review shop drawings prior to submittal to the Project Designer. All shop drawings shall indicate how materials relate to conditions of the project. Standard manufacturer's drawings that do not show how and where material is to be used will not be reviewed by the Project Designer. Shop drawings shall not be reproductions of contract documents. Coordination drawings are required in accordance with **Article 14.**"

E. ARTICLE 8 - MATERIALS, EQUIPMENT, EMPLOYEES

1. **Paragraph "e":** Delete the paragraph in its entirety and replace with the following: "The CM shall obtain written approval from the Project Designer for the use of products, materials, or equipment claimed as equal to those listed in the specifications. Such approvals shall be obtained

prior to the opening of the bids. The CM shall submit within thirty (30) calendar days following award of contract a complete list of materials to be used for the project for review and approval by the Project Designer. The list shall consist of materials, products and equipment as listed in the specifications, equals, or approved equals. When this list is approved by the Project Designer, no substitution will be permitted except in unusual or extenuating circumstances. If no list is submitted, the CM shall supply only materials, products, or equipment required by the specifications.”

2. **Paragraph "g":** Add the following to the end of the paragraph: “All construction personnel shall be respectful to all Wake Technical Community College staff and students. Any disrespect, harassment, unwelcome comments or advances from any construction personnel toward any staff member or student shall constitute sufficient grounds for Wake Technical Community College to request removal of any specific individuals from this project. Such action taken by the Owner shall not constitute grounds for a delay claim. The Owner will not be responsible for any delays caused to the project due to any individual being removed from the project. Project superintendents shall be held accountable for any incident of this nature.”

F. ARTICLE 11- PROTECTION OF WORK, PROPERTY, AND THE PUBLIC

1. **Paragraph "j":** Add the following paragraph: “In case emergency contact is required, the CM shall furnish the Owner with names and telephone numbers (day and night) of the project manager and superintendent. The numbers shall remain current for the duration of the project and shall be updated as required.”
2. **Paragraph "k":** Add the following paragraph: “The Owner will provide security as it deems prudent and necessary for its own protection. The CM shall be responsible for security and safety of the project within the project limits, including on-site materials. The CM and the Owner shall meet on a regular basis as required but not less than weekly to coordinate safety and security issues.”
3. **Paragraph "l":** Add the following paragraph: “The Owner will conduct normal operations for the duration of the project. Unless otherwise stated, the campus buildings will be occupied and will operate on a normal schedule. This means that the CM will be required to schedule work around regular operations, special events, visitors, and staff requirements. The CM shall coordinate with the Owner's representative to minimize any disruptions to the functions of the College.”
4. **Paragraph "m":** Add the following new paragraph and subparagraphs: “Wake Tech COVID-19 service provider guidance:
 - a. Please refer to the link for Wake Technical Community College’s vendor and contracted services provider guidance: <https://www.waketech.edu/about-wake-tech/administrative-offices/environmental-health-and-safety/coronavirus/contracted-services>
 - b. Contractor to submit their contract statement related to COVID requirements prior to work being performed.
 - c. General Guidelines
 - 1) A face mask must always be worn while inside campus buildings.
 - d. Washing hands with soap and water for at least twenty (20) seconds or using hand sanitizer with at least 60% alcohol if soap and water are not available.
 - e. Avoid shared use of phones, tools, or other equipment.
 - f. Employees exhibiting symptoms or unable to self-certify must be directed to NOT report to work and seek medical attention from his or her health care provider. These employees are not to return to the work site until cleared by a medical professional.
 - g. In the event an employee that was on campus tests positive, contractor will immediately notify the Wake Technical Community College project manager so that tracking and additional sanitation can take place.”

G. ARTICLE 12- SEDIMENTATION POLLUTION CONTROL ACT OF 1973

1. **Paragraph "e":** Add the following new paragraph: “The CM shall comply with the following requirements: Equipment utilized during the construction activity on a site must be operated and maintained in a manner as to prevent the potential or actual pollution of the surface or ground waters. Fuels, lubricants, coolants, and hydraulic fluids, or any other petroleum products, shall not

be discharged on the ground or into surface waters. Spent fluids shall be disposed of in an immediate manner so as not to enter the waters, surface or ground, and in accordance with applicable state and federal disposal regulations. Any spilled fluids shall be cleaned up to the extent practicable and disposed of in an immediate manner so as not to allow their entry into the waters, surface or ground, storm sewers, or drains on private or public property. Herbicide, pesticide, and fertilizer usage during the construction activity shall be restricted to those Materials approved by EPA and shall be used in accordance with label instructions. All wastes composed of construction materials shall be disposed of in accordance with NC General Statutes, Chapter 130A, Article 9- Solid Waste Management, and rules governing the disposal of solid waste (NC Administrative Code Section 15A NCAC 13B)."

2. **Paragraph "f":** Add the following new paragraph: "Minimum Monitoring and Reporting Requirements
 - a. All sedimentation and erosion control of facilities shall be inspected by the CM at least once every seven calendar days and within 24 hours after any storm event of greater than 0.5 inches of rain per 24-hour period.
 - b. Storm water runoff discharges shall be inspected by visual observation for color, foam, outfall, staining, visible sheens, dry weather flows and muddy water (at the frequency described above) to evaluate the effectiveness of the pollution control facilities or practices. If any visible off-site sedimentation is leaving the site, corrective action shall be taken to reduce the discharge of sediments.
 - c. The CM shall submit to the Owner a written report of weekly inspections. Visible sedimentation found off the site shall be recorded with a brief explanation as to the measures taken to prevent future releases as well as any measures taken to clean up the sediment that has left the site. This record shall be made available to Department of Environmental Management or authorized agent upon request.
3. **Paragraph "g":** Add the following new paragraph: "Maintenance and Inspections
 - a. The CM shall keep all erosion controls devices and materials in good repair. The Owner reserves the right, within 24 hours prior notice to the CM to repair any erosion control measures or materials as required and deduct the cost of those repairs from the CM's application for payment.
 - b. The owner's representative may periodically evaluate the project for compliance with these requirements."

H. **ARTICLE 15 – NOT USED** (Replace Article 15 with the following):

ARTICLE 15 – E-Verify

- a. E-Verify Compliance: Pursuant to Session Law 2013-418, Contractor shall fully comply with the U.S. Department of Homeland Security employee legal status E-Verify requirements for itself and all its subcontractors. Owner requires an affidavit attesting to Contractor's compliance. Violation of the provision, unless timely cured, shall constitute a breach of contract.

I. **ARTICLE 19 – CHANGES IN THE WORK**

1. **Paragraph "b":** Replace: "transmitted by fax" with "transmitted electronically." Add the following new paragraph: "CM Contingency shall not be used without prior approval of Owner and execution of the CM Contingency Field Change form by Designer, CM, and Owner."
2. **Paragraph "k":** Add the following new paragraph: "Change orders will be approved via Interscope+ and the CM shall be registered with appropriate access to the system. Proposed Change Orders (PCO) shall have a unique numerical designation that will correspond to an Interscope+ PCO number if it is an approved change. CM Contingency approved for use shall be processed into Interscope as a PCO with a zero-dollar change and will include back-up documentation similar to all other PCOs. All PCOs shall be assigned one of the following cause codes:
 - a. Owner Request (OR)
 - b. Contractor Request (CR)
 - c. Designer Request (DR)

- d. Concealed Condition (CC)
- e. Design Error (DE)
- f. Design Omission (DO)
- g. Schedule Change (SC)
- h. Scope Gap (SG)
- i. Contract Default (CD)
- j. Unforeseen Conditions (UC)
- k. Other (OT)"

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

- 1. **Paragraph "a"**: Add the following to the end of the paragraph: "The time of completion for this project is **345** consecutive calendar days from the date stated in the designer's Notice to Proceed issued to the CM."
- 2. **Paragraph "b"**: Add the following to the end of the paragraph: "Liquidated damages are in the amount of **\$1,000.00** per calendar day."

K. Modifications to Article 34 – Minimum Insurance Requirements:

- 1. Revise 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)"

L. Modifications to Article 40 - Utilities, Structures, Signs:

- 1. Paragraph a is clarified as follows: The CM shall pay all utilities up to the day following completion and acceptance of the CM's work. In the case of Beneficial Occupancy, the cost of utilities after the date of Beneficial Occupancy will be based on a mutually agreed upon percentage of the cost of utilities provided to the owner accepted areas.
- 2. Add the following to Paragraph l: The Contractor is responsible for all utility, structure, and sign requirements and costs as specified in section 015000 - Temporary Facilities and Controls.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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**Report of Subsurface Investigation and
Geotechnical Engineering Evaluation
Wake Technical Community College
Fire and Rescue Training Center
Wendell, North Carolina
prepared for
Wake Technical Community College**

Prepared by

NV5 Engineers and Consultants, Inc.
NC Engineering Corporation F-1333
3300 Regency Parkway #100 | Cary, N
919-876-9799

RECEIVED
03/25/2025
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January 11, 2024

Mr. Walter Lennon
Wake Technical Community College
wlennon@waketech.edu

**Report of Subsurface Investigation
and Geotechnical Engineering Evaluation
Wake Technical Community College
Fire and Rescue Training Center
Wendell, North Carolina
Our Project Number 121-23-113900**

Dear Mr. Lennon:

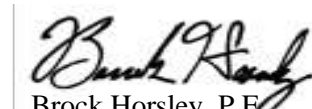
NV5 Engineers and Consultants, Inc. has completed the authorized subsurface investigation and engineering evaluation for the above referenced project. The enclosed report describes our investigative procedures and presents the results of our testing and evaluation along with comments regarding the geotechnical aspects of this project.

We appreciate the opportunity to work with you on this subsurface investigation and engineering evaluation and are prepared to follow up with the recommended construction materials testing services.

If you have any questions concerning this report, please contact us.

Sincerely,
NV5 Engineers and Consultants, Inc. (F-1333)


Jalen G. Deatherage
Associate Project Manager


Brock Horsley, P.E.
Principal Geotechnical Engineer

NV5 Engineers and Consultants, Inc.
NC Engineering Corporation F-1333
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SCOPE OF SERVICES

The scope of this study was outlined in our proposal dated October 18, 2023. The main objective of the study was to evaluate the subsurface conditions at the subject site and to make recommendations regarding the geotechnical aspects of site preparation, foundation design, and construction. More specifically, the scope of this investigation included the following objectives:

- (1) To evaluate the existing subsurface soil and groundwater conditions within the planned construction area.
- (2) To provide general recommendations for site preparation and site grading, including our evaluation of the potential for rock excavation.
- (3) To provide recommendations for foundation design, including evaluation of the sustainability suitability of the expected shallow foundations, and the allowable soil bearing pressure for support of shallow foundations.
- (4) To make recommendations concerning control of groundwater during construction and on a permanent basis, if necessary.
- (5) To evaluate the suitability of shallow foundation systems for support of the planned construction, and to provide recommendations for a design allowable bearing pressure.
- (6) To provide an evaluation of the Seismic Site Classification.
- (7) To provide recommendations for material types and thicknesses for the planned bituminous concrete pavement systems in the planned parking and driving areas.
- (8) To provide recommendations for achieving high density structural fill capable of satisfactorily supporting the proposed construction.
- (9) To provide pertinent recommendations for construction quality control measures.

INVESTIGATIVE PROCEDURES

Field Investigation

Our subsurface investigation consisted of twenty-two (22) soil test borings within the proposed construction areas (B-1 to B-22). The test boring locations are approximately shown on Figure 1 included in the Appendix. The test borings were performed to approximate depths of 10 feet (B-16 to B-22), 15 feet (B-12 to B-15), and 25 feet (B-1 to B-11) below the existing ground surface.

The locations of the test borings were identified in the field by our representative by using GPS coordinates, a handheld GPS receiver, and measuring distances and angles from known references points. Our scope of services did not include surveying of the planned construction areas or the locations of the test borings. In general, the locations of the test borings should be considered approximate. Ground surface elevations of the test borings were not available.

The test borings were performed using the procedures described in ASTM D-1586. Drilling was completed with an ATV-mounted drill rig equipped with an automatic hammer at 85.4% efficiency. Standard Penetration Testing (SPT) was performed at selected intervals in the test borings to evaluate the strength, relative density and consistency of the soils encountered. The penetration resistance, in conjunction with soil classifications, provides some indication of the engineering characteristics of the soils encountered. ***The standard penetration resistances (N-values) in this report have been energy-corrected for the specific automatic hammer used in this evaluation to a standard penetration resistance of a hammer operating at 60% efficiency (N₆₀).***

Detailed descriptions of the soils encountered in each of the test borings are provided in the Test Boring Records included in the Appendix. Groundwater conditions, penetration resistances, and other pertinent information are also included. Since our samples are taken at discrete locations and depths, variations in the materials could be present that are not detected by our industry standard testing procedures used for this project and cannot be delineated in the Test Boring Records.

Laboratory Investigation

The laboratory investigation consisted of a physical examination and classification of all samples obtained from the drilling operation. Classification of the soil samples was performed in general accordance with ASTM D-2488 (Visual-Manual Procedure for Description of Soils). Soil classifications include the use of the Unified Soil Classification System described in ASTM D-2487 (Classification of Soils for Engineering Purposes). The Visual-Manual procedure used for soil classification is a qualitative analysis performed in conjunction with the education, experience and professional judgment of our geotechnical engineer. Quantitative analysis of soil properties, such as those referenced in ASTM D-2487, could result in different soil classifications. In these instances, adjustments to the design and construction may be necessary, depending on the actual conditions. The soil classifications also include our evaluation of the geologic origin of the soils. Evaluations of geologic origin are based on our experience and interpretation and may be subject to some degree of error.

GENERAL SITE AND SUBSURFACE CONDITIONS

Site Location and Description

The site is in the northeast portion of the planned Wake Tech East campus at 5403 Rolesville Road in Wendell, North Carolina. The area southwest of the site consists of completed and ongoing construction for the planned campus. The site consists of a wooded area to the northeast of Inspiration Circle. US-64 is present along the northwest side of the site. Buffalo Creek is present along the east side of the site, and an unnamed stream is present along the south side of the site. A residential subdivision is present to the east, commercial buildings are present to the south and west, and commercial and wooded areas are present to the north.

Based on our review of information available on the Wake County GIS website and observations during our site walkover, the site generally slopes downward from a knoll in the north-central portion of the site toward the south and east with an overall relief of approximately 24 feet.

Regional Geology

Based on a review of geologic maps, it appears that the site is located within the Raleigh Belt of the Piedmont Geologic Province of North Carolina. Soils in this area have been formed by the in-place weathering of the underlying igneous crystalline rock, which accounts for their classification as "residual" soils. Soils in this area generally consist of sandy silts, silts and clays. However, pockets of relatively plastic silts and clays have been encountered within less plastic, coarser grained soils, in many instances. Boulders are commonly encountered within the residual soil mass in this area. Alluvial deposits are common in the areas of creeks and streams.

The residual soils typically become less weathered, coarser grained, and much harder with increased depth. When the residual materials have a standard penetration resistance of 100 blows per foot or greater, they are referred to as partially weathered rock. The transition from soil to partially weathered rock is usually a gradual one and may occur at a wide range of depths. Lenses or layers of partially weathered rock are not unusual in the soil profile.

Partially weathered rock represents the zone of transition between the soil and the underlying rocks from which the soils are derived. The subsurface profile is, in fact, a history of the weathering process. The degree of weathering is most advanced at the ground surface, where fine grained soil may be present. The weathering process is in its early stages immediately above the surface of relatively sound rock, where partially weathered rock may be found.

The thickness of the zone of partially weathered rock and the depth to the rock surface have both been found to vary considerably over relatively short distances. The depth to the rock surface in the area has generally been found to range from about 10 to 60 feet below the ground surface.

Stream valleys in this area often contain alluvial (water deposited) soils, depending on ground surface topography, stream flow characteristics, and other factors. By nature, alluvial soils can be highly variable depending upon the energy regime at the time of deposition. Coarse materials such as sand or gravel are deposited in higher energy environments, while fine grained materials such as silt and clay are deposited in low energy environments. Alluvial soils may also contain significant amounts of organic materials, and are frequently in a loose, saturated condition. In many cases, fine grained alluvial soils will be highly compressible and have relatively low shear strength.

General Subsurface Conditions

Approximately 7 to 8 inches of topsoil were encountered in all of the test borings. The thickness of topsoil materials may be quite variable and could be significantly different at other locations on the site. This is

especially true in wooded areas, where our experience indicates that topsoil thicknesses are typically greater. Therefore, the reported topsoil thickness should not be used for detailed quantity estimates.

Beneath the topsoil in all soil test borings, residual soils were encountered. The residual soils consisted of sandy and silty clays (CL), sandy silts (ML), silty sands (SM), and elastic silts (MH) that extended to boring termination depths of approximately 5.5 to 25 feet below the existing ground surface. The elastic silts were encountered in test borings B-11 and B-14 at depths of approximately 5.5 to 25 feet and 8 to 20 feet, respectively. The energy-corrected standard penetration resistances (N_{60} values) in the elastic silts ranged from weight of hammer (0) to 4 blows per foot. In the upper approximate 3 feet of test borings B-2, B-6 to B-12, B-14, B-15, and B-20 to B-22, N_{60} values ranged from 3 to 10 blows per foot. In test borings B-9, B-11, B-14, and B-17, N_{60} values ranged from weight of hammer (0) to 46 blows per foot throughout the depths explored. In the other test borings and below the upper approximate 3 feet in the above mentioned test borings, N_{60} values ranged from 11 to 98 blows per foot.

Partially weathered rock was encountered in B-2 to B-8, B-10, B-12, B-13, B-15, and B-19. Partially weathered rock denotes residual material which has a standard penetration resistance of 100 blows per foot or greater. The depth to the surface of the partially weathered rock ranged from 3 to 12 feet below the existing ground surface.

Auger refusal was encountered in test borings B-3, B-4, B-6, B-7, B-8, B-10, B-13, and B-19 at depths of approximately 5 to 23.5 feet below the existing ground surface. Auger refusal is the depth at which the boring cannot be further advanced using conventional soil drilling techniques. The materials causing auger refusal may consist of a boulder, a lens or layer of rock, the upper surface of relatively massive rock, or other hard material.

At the time of the drilling operation, groundwater was encountered in test borings B-1, B-4, B-11, and B-14 at depths of approximately 9 to 16 feet below the existing ground surface. It should be noted that groundwater levels will fluctuate, depending on seasonal variations of precipitation and other factors, and may occur at higher elevations at some time in the future. For more detailed descriptions of subsurface soil and groundwater conditions, please refer to the Test Boring Records included in the Appendix.

Proposed Construction

Project information has been provided by Mr. Michael Allen with NV5 Engineers and Consultants, Inc., we understand that construction will consist of a planned fire rescue and training center for the Wake Tech East campus which will include several structures, associated parking and drive areas, and three (3) stormwater ponds. The planned construction will include an auxiliary building, an apparatus bay, a burn materials covered storage, a training tower, a burn building, and a shade structure. Additional site features include a technical rescue area, a roof ventilation prop, a dumpster pad, a flashover prop, a drafting pit, a vehicle extraction, a hazmat training pad, a propane tank storage area, an outdoor fire prop pad, a future prop area, and a mechanical yard. The planned parking areas include approximately 40 automobile parking spaces and 5 fire truck parking spaces. For purposes of this report, we have estimated traffic of 200 automobiles per day, 1 dumpster truck per week, 1 delivery truck per week, and 25 fire trucks per day. If actual traffic volumes are greater than these assumed maximums, please contact us and we will review our recommendations for their applicability. Provided loading information is shown in the following table.

Planned Structure	Provided Column Loads	Provided Wall Loads
Auxiliary Building	30 kips (max)	--
Apparatus Bay	--	7.5 kips per lin. ft. (max)
Shade Structure	--	4 kips per lin. ft. (max)
Burn Materials Covered Storage	10 kips (max)	--
Burn Building	284 kips (max), 169 kips (typical)	--
Training Tower	253 kips (max), 177 kips (typical)	--

EVALUATIONS AND RECOMMENDATIONS

The following recommendations are based on the information available on the proposed construction, the data obtained from our field and laboratory investigation, and our experience with soils and subsurface conditions similar to those encountered at this site. Please note that the soil test borings represent a very small statistical sampling of subsurface conditions. Therefore, conditions may be encountered during construction that are substantially different than those indicated by the borings. In these instances, adjustments to the design and construction may be necessary depending on actual conditions.

General Site Preparation

All trees, underbrush, weeds, grass, topsoil, roots, and other deleterious materials should be removed from the proposed construction area. Special attention should be given to the removal of tree stumps within the proposed construction area. Extensive root systems and localized soft soils are commonly encountered during removal of large tree stumps. Site clearing, grubbing, and stripping should be performed only during dry weather conditions. Operation of heavy equipment on the site during wet conditions could result in excessive mixing of topsoil and organic debris with clean underlying soils.

Soft/loose near surface soils were encountered in the upper approximate 3 feet of test borings B-2, B-6, B-7, B-8, B-9, B-20, B-21, and B-22, and it is possible that soft/loose near surface soils could be encountered in unexplored portions of the site, especially near the low-lying portions of the site. Depending on the conditions encountered at the time of construction and the planned grading, it is possible that excavation and replacement of the soft/loose near surface soils with structural fill soils will be required. As an alternative, where the soft, wet soils do not extend to depths greater than 2 feet below the ground surface, drying and recompacting the soils in-place may reduce the volume of undercut required.

Elastic silts were encountered at approximate depths of 5.5 to 25 feet in soil testing boring B-11 and at approximate depths of 8 to 20 feet in soil testing boring B-14. These soils are typically difficult to work with when wet, and equipment mobility on the site will be limited during times of wet weather. Elastic silts may be encountered in unexplored portions of the site. We suggest that site grading operations occur during dry weather conditions. In general, we recommend that if any elastic silts are encountered that they be removed in the upper 3 feet in building and pavement areas. Elastic silts can possibly be used as fill in areas to be landscaped, in areas where at least 3 to 5 feet of low plasticity soils can be placed above them, and within pond dam construction.

After completion of site clearing, we recommend that proofrolling operations be performed. All areas of the site which are to receive fill should be proofrolled prior to placement of structural fill. Areas of proposed excavation should be proofrolled after rough finished subgrade is achieved. Proofrolling should be performed using a loaded dump truck weighing at least 25 tons. Proofrolling should be accomplished by performing at least 3 passes in each of two perpendicular directions within entire construction areas, and 10 feet beyond. Any unsuitable materials that may be present, and any low consistency soils that are encountered which cannot be adequately densified in place, should generally be removed and replaced with well compacted fill material placed in accordance with the Structural Fill section of this report. Proofrolling should facilitate the identification of soft surficial soils but should not be expected to reveal soft conditions more than 2 feet below the ground surface at the time of proofrolling.

We recommend that site preparation operations be performed during times of dry weather. While wet weather can occur at any time during the year, the summer and early fall are times when drier weather is generally prevalent. Scheduling site grading during this time frame would reduce the probability of softening of the near surface soils from inclement weather conditions. If the existing soils at the site become softened from exposure to inclement weather, they should be dried, if necessary, and compacted to a minimum of 95 percent of their standard Proctor maximum dry density prior to fill placement operations or roadway construction.

During site preparation, burn pits or trash pits may be encountered. On sites located in developed areas, this is not an unusual occurrence. All too frequently, such buried material occurs in isolated areas which are not detected by the soil test borings. Any buried waste, construction debris, or trash which is found during the construction operation should be thoroughly excavated and removed from the site.

Excavation Characteristics

For the purpose of discussing excavation characteristics, the materials found in the previous and recent test borings and/or expected at the site may be placed into three broad categories: (1) residual soils, (2) partially weathered rock, and (3) rock.

The majority of the residual soils at the project site should generally be excavatable with conventional soil excavation equipment, such as scrapers, loaders, etc. However, harder residual soils (penetration resistances above 50 blows per foot) may be difficult to excavate. Ripping of harder soils may be required to efficiently achieve excavation.

Partially weathered rock was encountered in B-2 to B-8, B-10, B-12, B-13, B-15, and B-19 to depths of approximately 3 to 25 feet below the existing ground surface. Although materials identified as partially weathered rock may in some cases be excavatable with conventional soil excavation equipment, we believe that it is wise to assume that partially weathered rock will require ripping to efficiently achieve excavation. The thickness and the continuity of partially weathered rock should be expected to vary widely even over a relatively short distance. Additionally, it would not be unusual to find additional lenses of partially weathered rock within more weathered residual soils. It should be noted that some of the test borings encountered zones of partially weathered rock which allowed little or no penetration of our sampling equipment. These zones are indicated on the Test Boring Records by penetration resistances of 50 blows for 6 inches or less. It is likely that these zones of partially weathered rock cannot be efficiently pre-loosened by ripping. In such instances, blasting will be necessary.

Ripping can probably best be achieved with a single-tooth ripper mounted on a large tractor such as a Caterpillar D-8 or larger. In small area excavations, such as footing and utility trenches, excavation of partially weathered rock may require the use of heavy excavators or pneumatic jackhammers.

Rock was encountered in our test borings B-3, B-4, B-6, B-7, B-8, B-10, B-13, and B-19, to the boring termination depths of 5 to 23.5 feet below the existing ground surface. Rock, as used in this report, is defined as auger refusal of our conventional soil drilling equipment. For planning purposes, we believe it would be prudent to assume that blasting or other methods will be required for excavations below these depths.

We recommend that the project specifications include a clear definition of excavation types to prevent field discussions regarding excavation of hard materials. We have enclosed our standard Rock Excavation Specifications for your use. We recommend that these be incorporated into the project earthwork specifications.

It is important to note that the depth to rock or partially weathered rock may vary quite rapidly even over relatively short distances. It would not be unusual for rock or partially weathered rock to occur at higher elevations between or around the soil test borings. Additionally, it is important to realize that groundwater levels will fluctuate and could occur at significantly higher elevations at some time in the future.

Earth Slopes

Temporary construction slopes should be designed in strict compliance with the most recent OSHA regulations. The test borings indicate that there are Type B (clay and silt) and Type C (sand) materials as defined in the *Occupational Safety and Health Standards for the Construction Industry (29 CFR, Part 1926, Subpart P), July 1, 2001*. This dictates that temporary construction slopes for excavation depths up to 20 feet can be no steeper than the following horizontal (H) to vertical (V) ratios:

OSHA Soil Type	USCS Soil Classification	Maximum Temporary Slope (H:V)
Type B	ML, MH, and CL	1:1
Type C	SM	1.5:1

Any otherwise unsuitable soils may require flatter excavation slopes. We note that blasted rock should not be considered stable rock and will likely require flatter excavation slopes. A competent person as defined by OSHA guidelines should be present to determine the type of material exposed during trench excavations. Temporary construction slopes should be closely observed for signs of mass movement: tension cracks near the crest, bulging at the toe of the slope, etc. If potential stability problems are observed, the geotechnical engineer should be immediately contacted. The responsibility for excavation safety and stability of construction slopes should lie solely with the contractor.

We recommend that permanent cut or fill slopes be no steeper than 2.5 (H) to 1.0 (V) to maintain long term stability and to provide ease of maintenance. Slopes constructed steeper than 2.5 (H) to 1.0 (V) could be highly susceptible to erosion, will be difficult to maintain, and could experience large scale slope failure in some instances. The crest or toe of cut or fill slopes should be no closer than 15 feet to any building foundation. The crest or toe should be no closer than 5 feet to the edge of any pavements.

Groundwater Control

As noted above, groundwater was encountered in our test borings B-1, B-4, B-11, and B-14. Perched groundwater conditions were present in test borings B-2, B-4 through B-10, B-12 through B-15, and B-22. Perched groundwater conditions consist of sandy soils on top of impermeable layers such as clay or partially weathered rock. If groundwater is encountered in shallow excavations, including foundation and utility trench excavations, construction dewatering may be performed by pumping directly from the trench excavations. If pumping from trench excavations proves to be ineffective, then the use of well points or other methods may be required. Pumping from dewatering trenches should be done with care to prevent loss of soil fines, boils, or instability of slopes. In certain cases, gravity flow in a trench may be sufficient for effective dewatering.

We must emphasize that dewatering requirements will be dictated by groundwater conditions at the time of construction. The contractor should use a technique or combination of techniques which achieves the desired result under actual field conditions.

Seasonal High Water Table Evaluation

SCM #1

We evaluated the depth to the seasonal high-water table (SHWT) in the area of the planned pond SCM #1 (B-12). Residual soils consisting of sandy silts (ML) were encountered at this location in the upper approximate 5.5 feet. Residual soils consisting of silty sands (SM) were encountered at this location from a depth of 5.5 to 12 feet. Layers of partially weathered rock were below this depth to the boring termination depth of approximately 15 feet below the existing ground surface. Groundwater was not encountered in test boring B-12. A review of soil information available from the USDA Web Soil Survey indicates that in the area of test boring B-12, Rawlings (RgC) series soils are present. The RgC soils have a reported water table of greater than 80 inches. Based on the review of soil test boring B-12 groundwater was not encountered to the termination depth of 15 feet. Therefore, it is our opinion that the SHWT for SCM #1 is greater than 80 inches below the existing ground surface.

SCM #2

We evaluated the depth to the seasonal high-water table (SHWT) in the area of the planned pond SCM #2 (B-13). Residual soils consisting of silty sands (SM) were encountered at this location in the upper

approximate 3 feet. Layers of partially weathered rock were below this depth to the boring termination depth of approximately 5.5 feet below the existing ground surface. Groundwater was not encountered in test boring B-13. A review of soil information available from the USDA Web Soil Survey indicates that in the area of test boring B-13, Rawlings (RgC) series soils are present. The RgC soils have a reported water table of greater than 80 inches. Based on the review of soil test boring B-13 groundwater was not encountered to the termination depth of 5.5 feet. Therefore, it is our opinion that the SHWT for SCM #2 is greater than 80 inches below the existing ground surface.

SCM #3

We evaluated the depth to the seasonal high-water table (SHWT) in the area of the planned pond SCM #3 (B-14 and B-21). For test boring B-14, residual soils consisting of sandy clays (CL) were encountered at this location in the upper approximate 3 feet, silty sands from 3 to 5.5 feet, silty clays (CL) from 5.5 to 8 feet, and elastic silts (MH) from 8 to the termination depth of 20 feet below the existing ground surface. Groundwater was encountered in test boring B-14 at approximately 9 feet below the existing ground surface. For test boring B-21, residual soils consisting of silty sands (SM) were encountered at this location in the upper approximate 3 feet and sandy silts were encountered from 3 feet to the termination depth of approximately 10 feet below the existing ground surface. Groundwater was not encountered in test boring B-21. A review of soil information available from the USDA Web Soil Survey indicates that in the area of test boring B-14 and B-21, Chewacla and Wehadkee (ChA) series soils are present. The ChA soils have a reported seasonal high water table of 0 to 12 inches. Our experience indicates that this is likely due to the presence of floodplain soils associated with the adjacent stream and is a perched groundwater condition. Therefore, it is our opinion that the SHWT for SCM #3 is within the upper foot of the existing ground surface.

Foundation Design

After the above-described site preparation and site grading are complete, it is our opinion that the proposed structures may be supported on conventional shallow foundations. Based on the test boring results, provided structural loading conditions, and our past experience, ***we recommend that the shallow foundations be designed using an allowable soil bearing pressure of 2,500 pounds per square foot (psf) for all proposed structures. It is important to note that our allowable soil bearing pressure is based on the provided structural loading conditions for each structure. If any loads for any structure exceeds the provided maximums, please contact us for reevaluation.*** The use of this allowable soil bearing pressure assumes that any soft/loose soils in the upper approximate 3 feet of finished grades will be removed and replaced with suitable compacted structural fill or ABC stone. This also assumes that finished site grades in the planned building area will be at or above the existing site grades. Based on our assumed site preparation, loading conditions, and the site elevation information above, the estimated total foundation settlement is expected to be less than 1 and differential settlement less than ¼ inch if the recommended foundation bearing pressure is used. Please contact us to reevaluate our recommendations if actual loads are greater than the provided anticipated loads.

We recommend a minimum width of 18 inches for continuous wall footings and 24 inches for isolated column footings to prevent localized shear failure. Footings should bear at a minimum depth of 18 inches below the prevailing exterior ground surface elevation to provide the recommended bearing capacity and to avoid potential problems due to frost heave.

Detailed footing examinations should be performed in each footing excavation prior to placement of reinforcing steel. These examinations should be performed by our representative to confirm that the design allowable soil bearing pressure is available. The footing examinations should be performed using a combination of visual observation, hand rod probing, and dynamic cone penetrometer testing. Dynamic cone penetrometer testing, as described in ASTM STP-399, should be performed at no greater than 20-foot intervals in continuous wall footings. If the shallow subsurface conditions are not suitable for the recommended design bearing capacity, our representative will review the conditions with our project

Geotechnical Engineer. Recommendations will be developed to be immediately implemented in order to minimize construction delays.

Soft/loose soils were encountered in the upper approximate 3 feet of test borings B-2, B-6, B-7, B-8, B-9, B-20, B-21, and B-22, and it is possible that some soft/loose near surface soils may also be encountered in unexplored portions of the site. If these soils are not removed and replaced during site grading operations, remedial measures will likely be required during foundation construction.

We must emphasize the importance of quality control during the placement of structural fill. Performance of building foundations which are supported by structural fill material will depend largely on achieving the recommended level of compaction on fill materials. Compacted soil densities less than the recommended percentage of the standard Proctor maximum dry density could result in excessive foundation settlement.

Exposure to the environment may weaken the soils at the foundation bearing surface if they are exposed for extended periods of time. If the foundation bearing surface becomes softened due to exposure, the soft soils should be removed prior to placement of concrete.

Concrete Slabs-On-Grade

Based on our test boring results, and the anticipated site grading operations, we recommend that a design modulus of subgrade reaction (k) value of 100 pounds per cubic inch (pci) be used for concrete slabs-on-grade. We note that this modulus of subgrade reaction value is the expected value for a 1 foot by 1-foot loaded area. If the structural design of the slab requires a subgrade reaction modulus value adjusted for the size or shape of the subject slab, please contact us for re-evaluation. This recommended value also assumes that any fill soils will consist of sandy silts and that the subgrade soils and fill soils will be compacted to a minimum of 98 percent of their standard Proctor (ASTM D-698) maximum dry density in the upper 12 inches.

In order to provide a stable working platform, we recommend that all slab-on-grade construction be underlain by a minimum 4-inch thickness of compacted ABC stone. We also recommend that a plastic vapor barrier be utilized.

Construction activities and exposure to the environment often cause deterioration of the prepared slab-on-grade subgrade. Therefore, we recommend that the subgrade soils be evaluated by our representative immediately prior to floor slab construction. This evaluation may include a combination of visual observations, proofrolling observations, and field density tests to verify that the subgrade has been properly prepared. If soft areas are encountered, recommendations for remedial measures should be provided by our project geotechnical engineer.

Pavement Design Recommendations

Based on the above-described site preparation recommendations, we anticipate that the pavement area subgrade soils will consist primarily of sandy silts and silty sands. Based on our experience, these materials may reasonably have a California Bearing Ratio (CBR) ranging from approximately 5 to 15, if compacted to at least 100% of the standard Proctor maximum dry density in the top 8 inches. The CBR could be different than these assumed values if off-site fill materials are imported.

For purposes of pavement design, we have used a California Bearing Ratio of 5 for the pavement subgrade soils and the loading conditions described previously in this report. Based on the AASHTO design method, a 20-year design life, and our past experience, we suggest the following design pavement sections for the planned development:

Pavement Type	Heavy Duty Flexible	Heavy Duty Flexible (Alternate)	Light Duty Flexible
Surface Course	2 inches S9.5B (two 1-inch lifts)	1.5 inches S9.5B (one lift)	3 inches S9.5B (two 1.5-inch lifts)
Intermediate Course	4 inches I19.0B	2.5 inches I19.0B	--
Base Course	8 inches ABC	10 inches ABC	8 inches ABC

The bituminous concrete surface course should be type S9.5B (2022), and the bituminous concrete intermediate course should be type I19.0B (2022) in accordance with Division 6 of the current NCDOT Standard Specifications. Aggregate base course (ABC) stone should be in accordance with Division 5 of the current NCDOT Standard Specifications. Proper subgrade compaction and adherence to the NCDOT and project specifications, along with pavement maintenance operations, are critical to proper pavement performance.

Pavement Type	Heavy Duty Rigid	Light Duty Rigid
Portland Cement Concrete (PCC)	6 inches NCDOT Class AA PCC (4500 psi at 28-days)	4 inches NCDOT Class A PCC (3000 psi at 28 days)
Base Course	6 inches ABC stone	4 inches ABC stone

Construction joints and other design details should be in accordance with guidelines provided by the Portland Cement Association and the American Concrete Institute. The rigid pavement system should be constructed in accordance with section 700 of the NCDOT Standard Specifications.

The recommended pavement sections are designed to support the traffic volumes expected after completion of the planned construction. If construction traffic is allowed to use the recommended pavement sections, some damage requiring repair should be expected.

Seismic Site Classification

We have reviewed our test boring results and pertinent geological maps to determine a seismic site classification in accordance with the International Building Code (IBC). The IBC provides a method to estimate a site's seismic classification based on the average standard penetration resistances of the upper 100 feet of a soil profile. Our maximum test boring depth was to an approximate depth of 25 feet below the existing ground surface. We have also used the results of test borings performed on other sites in the area, as well as our experience with similar conditions, to estimate the seismic classification for the subject site. Based on our review, experience, and the results of our test borings, the site should be classified as **Type D** in accordance with the IBC. If the Seismic Site Classification is critical to design, consideration should be given to performing shear wave testing at the site to confirm the Seismic Site Classification.

Suitability of Excavated Material for Reuse as Structural Fill

Based on the field and laboratory investigation performed, the residual sandy clays (CL), sandy silts (ML), and silty sands (SM) should generally be suitable for use as structural fill on the site. The elastic silts (MH) may only be used as structural fill 3 feet below the finish grades. The in-place maximum dry density of structural fill soils should be no less than 90 pounds per cubic foot. Some moisture conditioning will likely be required to obtain the recommended level of compaction.

Structural Fill

In order to achieve high density structural fill, the following recommendations are offered:

- (1) Materials selected for use as structural fill should be free of vegetable matter, waste construction debris, and other deleterious materials. The material should not contain rocks having a diameter over 3 inches. It is our opinion that the following soils represented by their USCS group symbols will typically be suitable for use as structural fill: (ML), (CL), (SM), and (SC). Due to the potential for developing a perched groundwater condition, the following soils should be considered unsuitable as structural fill: (SW), (SP), (SP-SM), and (SP-SC). At depths greater than 3 feet below finished grades, the following soil types will typically be suitable for use as structural fill: (CH) and (MH). The following soil types are considered unsuitable: (OL), (OH), and (Pt).
- (2) Laboratory Proctor compaction tests and classification tests should be performed on representative samples obtained from the proposed borrow material to provide data necessary to determine acceptability and for quality control. The moisture content of suitable borrow soils should generally not be more than 3 percentage points above or below optimum at the time of compaction. Tighter moisture limits may be necessary with certain soils.
- (3) Suitable fill material should be placed in thin lifts (lift thickness depends on type of compaction equipment, but in general, lifts of 8 inches loose measurement are recommended). The soil should be compacted by mechanical means such as steel drum or sheepsfoot rollers. Proofrolling with rubber tired, heavily loaded vehicles may be desirable at approximately every third lift to bind the lifts together and to seal the surface of the compacted area thus reducing potential for absorption of surface water following a rain. This sealing operation is particularly important at the end of the workday and at the end of the week. Within small excavations, we recommend the use of "wacker packers" or diesel sled tamps and loose lift thicknesses of 4 to 6 inches to achieve the specified compaction.
- (4) We recommend that structural fill be compacted to a minimum of 95% of the standard Proctor maximum dry density (ASTM Specification D-698). Additionally, the in-place maximum dry density of structural fill should be no less than 90 pounds per cubic foot (pcf). The upper 12 inches of floor slab subgrades should be compacted to at least 98% of the standard Proctor maximum dry density (ASTM D-698). Fill materials in pavement areas should be placed and compacted in accordance with NCDOT Standards and Specifications.
- (5) An experienced soil engineering technician should take adequate density tests throughout the fill placement operation to verify that the specified compaction is achieved. It is particularly important that this be accomplished during the initial stages of the compaction operation to enable adjustments to the compaction operation, if necessary.

ADDITIONAL SERVICES RECOMMENDED

Additional engineering and testing services recommended for this project are summarized below:

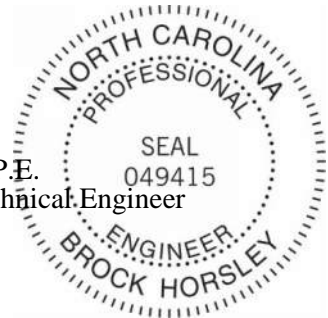
- (1) Site Preparation Observations: Proofrolling should be observed by our representative to determine if remedial measures are necessary in certain instances. Removal of any encountered unsuitable soils should be monitored by our representative to verify that adequate, but not excessive, removal is accomplished.
- (2) Quality Control of Fill Placement and Compaction: We recommend that an experienced engineering technician witness all required filling operations and take sufficient in-place density tests to verify that the specified degree of compaction has been achieved. Soil engineering judgments will be involved and should be made by our project geotechnical engineer with information provided by our engineering technician.
- (3) Footing and Slab Evaluations: Footing and slab areas for this project should be evaluated by our representative. The purpose of these evaluations will be to verify that the design soil bearing pressure is available and that subgrade areas are properly prepared.
- (4) Pavement Components Testing and Inspection: Pavement components should be tested and inspected during and following construction to verify compliance with project plans and NCDOT Standard Specifications.

The attached Appendix completes this report.

Sincerely,
NV5 Engineers and Consultants, Inc. (F-1333)


Jalen G. Deatherage
Associate Project Manager

Brock Horsley, P.E.
Principal Geotechnical Engineer



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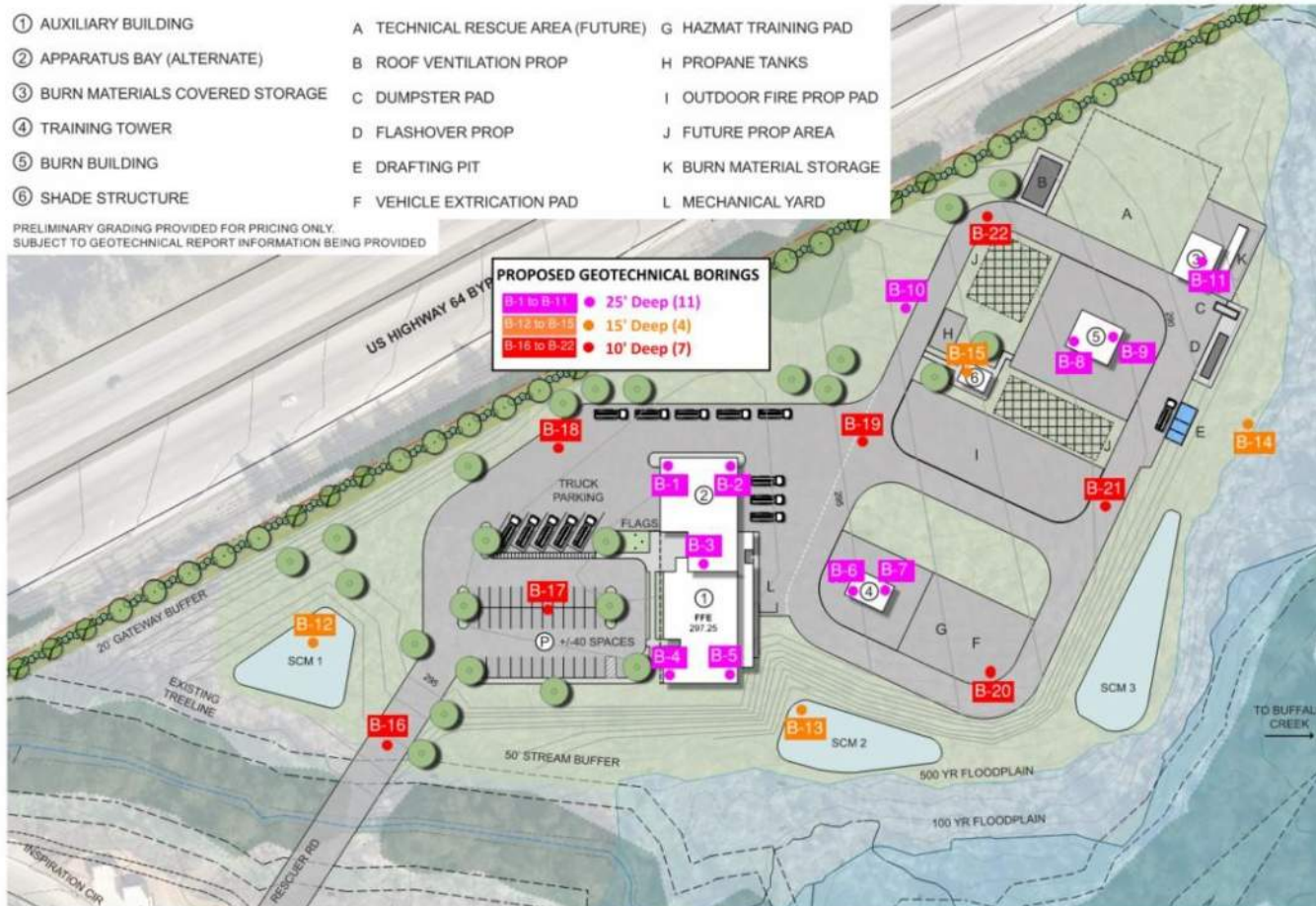
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APPENDIX

Rock Excavation Specifications

Excavation Classifications: The classifications of excavation below will be made when rock excavation is encountered in work. Do not perform such work until material to be excavated has been cross-sectioned and classified by the Geotechnical Engineer. Such excavation will be paid on basis of contract conditions relative to changes in work.

1. Earth excavation includes removal and disposal of pavements and other obstructions visible on surface; underground structures and utilities indicated to be demolished and removed; along with earth and other materials encountered that are not classified as rock or unauthorized excavation.
2. Rippable rock excavation consists of removal and disposal of a formation that can not be removed with standard soil excavation equipment such as backhoes and pans, but can be removed with a Caterpillar D-8 or equivalent bulldozer mounted with a single tooth ripper. Mass rock excavation consists of the removal and disposal of a formation that cannot be excavated with a Caterpillar D-8 bulldozer or equivalent, mounted with a single tooth ripper. Trenches in excess of 10 feet in width and pits in excess of 30 feet high in either length or width are classified as mass rock excavation.
3. In trench excavations for footings and utilities, trench rippable rock excavation shall be the removal and disposal of a formation that can not be excavated using standard soil excavation equipment such as a backhoe, but can be removed with a Caterpillar 322 track mounted excavator or similar equipment, equipped with a $\frac{3}{4}$ cubic yard bucket equipped with rock teeth.. In trench excavations for footings and utilities, trench rock excavation shall be the removal and disposal of a formation that cannot be excavated with a Caterpillar 322 track mounted excavator or equivalent, equipped with a $\frac{3}{4}$ cubic yard bucket equipped with rock teeth.
4. The owner's testing agency or architect shall be the final judge as to what is to be classified as rock excavation. The contractor shall provide the specified equipment at the site to confirm rock excavation.
5. Intermittent ripping or drilling and blasting to increase production and not necessary to permit excavation will be classified as earth excavation.
6. Rippable rock and rock payment lines are as follows:
 - A. Two feet outside of concrete work for which forms are required, except footings.
 - B. One foot outside perimeter of footings.
 - C. In pipe trenches, 6 inches below invert elevation of pipe and two feet wider than inside diameter of pipe, but not less than 3 feet minimum trench width.
 - D. For drainage structures, 18 inches outside of structure dimension, and 6 inches below bottom of structure.
 - E. Neat outside dimensions of concrete work where no forms are required.
 - F. Under slabs-on-grade, 6 inches below bottom of concrete slab.
 - G. Under pavements, 6 inches below planned subgrade elevation.
7. Field verification of rippable rock and rock quantities shall be performed by the owner's testing agency or a registered land surveyor.
8. Remove all excavated material classified as rock from the site.
9. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of the architect. Unauthorized excavation, as well as remedial work associated with unauthorized excavation, shall be at Contractor's expense.



Not to Scale

Figure 1. Approximate Boring Locations

Symbols and Nomenclature

I	Undisturbed Sample (UD)
●	Standard penetration resistance (ASTM D-1586)
100/2"	Number of blows (100) to drive the spoon a number of inches (2)
W-O-H, R	Weight of Hammer, Weight of Rods
AX, BX, NX	Core barrel sizes for rock cores
65%	Percentage of rock core recovered
RQD	Rock quality designation - % of core 4 or more inches long
▼	Water table at least 24 hours after drilling
▼	Water table one hour or less after drilling Loss of drilling water
△	A Atterberg Limits test performed
C	Consolidation test performed
GS	Grain size test performed
T	Triaxial shear test performed
P	Proctor compaction test performed
18	Natural moisture content (percent)








Penetration Resistance Results

Sands	SPT N-60-Value Penetration (blows/ft)	Relative Density Descriptor
	0-4	Very Loose
	5-10	Loose
	11-20	Firm
	21-30	Very Firm
	31-50	Dense
	Over 50	Very Dense
Silts and Clays	SPT N-60-Value Penetration (blows/ft)	Relative Density Descriptor
	0-1	Very Soft
	2-4	Soft
	5-8	Firm
	9-15	Stiff
	16-30	Very Stiff
	31-50	Hard
	Over 50	Very Hard





Drilling Procedures

Soil sampling and standard penetration testing performed in accordance with ASTM D-1586. The standard penetration resistance is the number of blows of a 140 pound hammer falling 30 inches to drive a 2 inch O.D., 1.4 inch I.D. split spoon sampler one foot. Core drilling performed in accordance with ASTM D-2113. Undisturbed sampling performed in accordance with ASTM D-1587.

SAMPLE/SAMPLER TYPE GRAPHICS

	AUGER SAMPLE
	STANDARD PENETRATION SPLIT SPOON SAMPLER
	BULK / GRAB SAMPLE
	MODIFIED CALIFORNIA SAMPLER
	SHELBY TUBE SAMPLER
	HQ ROCK CORE SAMPLE
	NQ ROCK CORE SAMPLE


























GROUNDWATER LEVEL GRAPHICS

	WATER LEVEL (during drilling operations)
	WATER LEVEL (immediately after drilling completion)
	WATER LEVEL (additional levels after drilling completion)
	OBSERVED SEEPAGE

NOTES

- The report and graphics key are an integral part of these logs. All data and interpretations in this log are subject to the explanations and limitations stated in the report.
- Lines separating strata on the logs represent approximate boundaries only. Actual transitions may be gradual or differ from those shown.
- No warranty is provided as to the continuity of soil or rock conditions between individual sample locations.
- In general, Unified Soil Classification System (USCS) designations presented on the logs were based on visual classification in the field and were modified where appropriate based on gradation and index property testing.
- If sampler is not able to be driven at least 6 inches then Y/X indicates Y number of blows required to drive the identified sampler X inches with a 140 pound hammer falling 30 inches.

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487)

GRAVELS (More than half of coarse fraction is larger than the #200 sieve)	CLEAN GRAVEL WITH <5% FINES	$Cu \geq 4$ and $1 \leq Cc \leq 3$		GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
		$Cu < 4$ and/or $1 > Cc > 3$		GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
	GRAVELS WITH 5 TO 12% FINES	$Cu \geq 4$ and $1 \leq Cc \leq 3$		GW-GM	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE FINES
		$Cu < 4$ and/or $1 > Cc > 3$		GW-GC	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE CLAY FINES
		$Cu < 4$ and/or $1 > Cc > 3$		GP-GM	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE FINES
				GP-GC	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE CLAY FINES
	GRAVELS WITH >12% FINES			GM	SILTY GRAVELS, GRAVEL-SILT-SAND MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
				GC-GM	CLAYEY GRAVELS, GRAVEL-SAND-CLAY-SILT MIXTURES
COARSE GRAINED SOILS (More than half of coarse fraction is smaller than the #4 sieve)	CLEAN SANDS WITH <5% FINES	$Cu \geq 6$ and $1 \leq Cc \leq 3$		SW	WELL GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
		$Cu < 6$ and/or $1 > Cc > 3$		SP	POORLY-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
	SAND WITH 5 TO 12% FINES	$Cu \geq 6$ and $1 \leq Cc \leq 3$		SW-SM	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE FINES
				SW-SC	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE CLAY FINES
		$Cu > 6$ and/or $1 < Cc > 3$		SP-SM	POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE FINES
				SP-SC	POORLY-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE CLAY FINES
	SANDS WITH >12% FINES			SM	SILTY SANDS, SAND-GRAVEL-SILT MIXTURES
				SC	CLAYEY SANDS, SAND-GRAVEL-CLAY MIXTURES
				SC-SM	CLAYEY SANDS, SAND-SILT-CLAY MIXTURES
FINE GRAINED SOILS (More than half of material is smaller than the #200 sieve)	SILTS AND CLAYS (Liquid Limit less than 50)			ML	INORGANIC SILTS AND VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS, SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				CL-ML	INORGANIC CLAYS-SILTS OF LOW PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS (Liquid Limit greater than 50)			MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILT
				CH	INORGANIC CLAYS OF HIGH PLASTICITY FAT CLAYS
				OH	ORGANIC CLAYS & ORGANIC SILTS OF MEDIUM-TO-HIGH PLASTICITY

Date	Started: 11/28/23		Project Number 121-23-113900		Project Wake Tech Fire & Rescue		Boring No. B-1							
	Completed: 11/28/23													
	Hammer Type: Automatic		Drilling Method: HSA		Logged By: JGD		Reviewed By: BPH							
Latitude:		Longitude:		Surface Elevation:										
Groundwater Depth (ft.)	Depth (ft.)	Graphical Log	Sample Taken	Sample ID	SPT N-Value	Moisture Content (%)	% Passing No. 200	Other Tests and Remarks	USCS Class.	Location: See Figure 1				
										Sample Type		Groundwater		
										G - Bulk / Grab Sample SPT - 2" O.D. 1.4" I.D. Tube Sample MC - 3" O.D. 2.4" I.D. Ring Sample NR - No Recovery * - Uncorrected Blow Counts		Depth (ft)	Hour	Date
												16		
										Visual Classification				
0										TOPSOIL 0.2' Topsoil (Approximately 2 inches)				
SPT- 1 5-5-5 N60=14										ML				
SPT- 2 4-6-8 N60=20										Stiff to very stiff brown orange fine to medium micaceous sandy silt (ML) (RESIDUUM)				
5										5.5'				
SPT- 3 7-9-13 N60=31										SM				
SPT- 4 5-4-6 N60=14										Dense tan brown fine to medium micaceous silty sand (SM)				
10										8.0'				
SPT- 5 3-4-4 N60=11														
15										SM				
SPT- 6 4-4-4 N60=11										Firm tan brown fine to medium micaceous silty sand (SM)				
20														
SPT- 7 3-7-5 N60=17														
25										25.0'				

Notes:
Boring terminated at approx. depth of 25.0 feet.
Groundwater at 16 feet and Cave in at 16.5 feet

Date		Started: 11/28/23		Project Number 121-23-113900						Project Wake Tech Fire & Rescue						Boring No. B-2	
		Completed: 11/28/23								Drilling Method: HSA						Logged By: JGD	
		Hammer Type: Automatic		Longitude:												Surface Elevation:	
Latitude:		Longtitude:								Location: See Figure 1							
Groundwater Depth (ft.)	Depth (ft.)							Graphical Log	Sample Taken	Sample ID	SPT N-Value	Moisture Content (%)	% Passing No. 200	Other Tests and Remarks	USCS Class.	Sample Type G - Bulk / Grab Sample SPT - 2" O.D. 1.4" I.D. Tube Sample MC - 3" O.D. 2.4" I.D. Ring Sample NR - No Recovery * - Uncorrected Blow Counts	
		Depth (ft)			Hour		Date										
		Visual Classification															
0										TOPSOIL	0.2'	Topsoil (Approximately 2 inches)					
				SPT- 1	4-2-3 N60=7					SM		Loose brown orange fine to medium silty sand (SM) (RESIDUUM)					
				SPT- 2	4-7-8 N60=21					ML	3.0'	Very stiff red orange fine to medium micaceous sandy silt (ML)					
5											5.5'						
				SPT- 3	9-13-18 N60=44												
				SPT- 4	13-27-24 N60=73					SM		Dense to very dense tan orange fine to medium silty sand (SM)					
10											12.0'						
				SPT- 5	6-7-9 N60=23					SM		Very firm to firm brown gray fine to medium micaceous silty sand (SM)					
15																	
				SPT- 6	3-7-7 N60=20												
20											22.0'						
										PWR		Partially weathered rock sampled as brown gray fine to medium silty sand (SM)					
25				SPT- 7	50/1 N60=100						25.0'						

Notes:
Boring terminated at approx. depth of 25.0 feet.
Cave in at 15 feet

Date	Started: 11/28/23		Project Number 121-23-113900		Project Wake Tech Fire & Rescue			Boring No. B-3					
	Completed: 11/28/23												
	Hammer Type: Automatic		Drilling Method: HSA			Logged By: JGD		Reviewed By: BPH					
Latitude:		Longitude:			Surface Elevation:								
Groundwater Depth (ft.)	Depth (ft.)	Graphical Log	Sample Taken	Sample ID	SPT N-Value	Moisture Content (%)	% Passing No. 200	Other Tests and Remarks	USCS Class.	Location: See Figure 1			
										Sample Type G - Bulk / Grab Sample SPT - 2" O.D. 1.4" I.D. Tube Sample MC - 3" O.D. 2.4" I.D. Ring Sample NR - No Recovery * - Uncorrected Blow Counts	Groundwater		
											Depth (ft)	Hour	Date
											Visual Classification		
0													
				SPT- 1	3-4-8 N60=17				ML	Very stiff orange brown fine to medium sandy silt (ML) with trace organics (RESIDUUM)			
										3.0'			
				SPT- 2	50/4 N60=100								
5				SPT- 3	50/5 N60=100								
				SPT- 4	50/5 N60=100								
10									PWR	Partially weathered rock sampled as white tan fine to coarse silty sand (SM)			
				SPT- 5	50/5 N60=100								
15													
										18.5'			

Notes:

Auger refusal at approx. depth of 18.5 feet.
Cave in at 15.5 feet

Date	Started: 11/28/23		Project Number 121-23-113900				Project Wake Tech Fire & Rescue				Boring No. B-4			
	Completed: 11/28/23													
	Hammer Type: Automatic		Drilling Method: HSA				Logged By: JGD				Reviewed By: BPH			
Latitude:		Longitude:				Surface Elevation:								
Groundwater Depth (ft.)	Depth (ft.)	Graphical Log	Sample Taken	Sample ID	SPT N-Value	Moisture Content (%)	% Passing No. 200	Other Tests and Remarks	USCS Class.	Location: See Figure 1				
										Sample Type		Groundwater		
										G - Bulk / Grab Sample SPT - 2" O.D. 1.4" I.D. Tube Sample MC - 3" O.D. 2.4" I.D. Ring Sample NR - No Recovery * - Uncorrected Blow Counts		Depth (ft)	Hour	Date
												15.5		
										Visual Classification				
<div> <div> <div>0</div> <div>5</div> <div>10</div> <div>15</div> <div>20</div> </div> <div> <div>TOPSOIL</div> <div>0.2' Topsoil (Approximately 2 inches)</div> <div>Stiff to very stiff orange brown fine to medium sandy silt (ML) (RESIDUUM)</div> <div>Very firm orange brown fine to medium silty sand (SM)</div> <div>Partially weathered rock sampled as orange brown fine to medium silty sand (SM)</div> </div> </div>														
<div> <div>SPT- 1</div> <div>4-4-6 N60=14</div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> </div>														
<div> <div>SPT- 2</div> <div>3-6-9 N60=21</div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> </div>														
<div> <div>SPT- 3</div> <div>5-7-7 N60=20</div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> </div>														
<div> <div>SPT- 4</div> <div>5-7-7 N60=20</div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> </div>														
<div> <div>SPT- 5</div> <div>8-9-11 N60=28</div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> </div>														
<div> <div>SPT- 6</div> <div>50/4 N60=100</div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> </div>														
<div> <div>23.5'</div> </div>														

Notes:
Auger refusal at approx. depth of 23.5 feet.
Groundwater at 15.5 feet and Cave in at 17 feet

Date	Started: 11/28/23		Project Number 121-23-113900		Project Wake Tech Fire & Rescue		Boring No. B-5							
	Completed: 11/28/23													
	Hammer Type: Automatic		Drilling Method: HSA		Logged By: JGD		Reviewed By: BPH							
Latitude:		Longitude:		Surface Elevation:										
Groundwater Depth (ft.)	Depth (ft.)	Graphical Log	Sample Taken	Sample ID	SPT N-Value	Moisture Content (%)	% Passing No. 200	Other Tests and Remarks	USCS Class.	Location: See Figure 1				
										Sample Type		Groundwater		
										G - Bulk / Grab Sample SPT - 2" O.D. 1.4" I.D. Tube Sample MC - 3" O.D. 2.4" I.D. Ring Sample NR - No Recovery * - Uncorrected Blow Counts		Depth (ft)	Hour	Date
Visual Classification														
0										0.1'	Topsoil (Approximately 1 inch)			
				SPT- 1	4-6-6 N60=17				SM		Firm red brown fine to medium silty sand (SM) (RESIDUUM)			
										3.0'				
5				SPT- 2	7-8-5 N60=19				ML		Very stiff orange brown fine to medium sandy silt (ML)			
										5.5'				
				SPT- 3	6-9-14 N60=33				SM		Dense orange brown fine to medium silty sand (SM)			
										8.0'				
10				SPT- 4	50/2 N60=100						Partially weathered rock sampled as orange brown fine to medium silty sand (SM)			
									PWR					
15				SPT- 5	50/1 N60=100						15.0'			

Notes:
Auger refusal at approx. depth of 15.0 feet.
Cave in at 12.5 feet

Date	Started: 11/29/23		Project Number 121-23-113900		Project Wake Tech Fire & Rescue		Boring No. B-6							
	Completed: 11/29/23													
	Hammer Type: Automatic		Drilling Method: HSA		Logged By: JGD		Reviewed By: BPH							
Latitude:		Longitude:		Surface Elevation:										
Groundwater Depth (ft.)	Depth (ft.)	Graphical Log	Sample Taken	Sample ID	SPT N-Value	Moisture Content (%)	% Passing No. 200	Other Tests and Remarks	USCS Class.	Location: See Figure 1				
										Sample Type		Groundwater		
										G - Bulk / Grab Sample SPT - 2" O.D. 1.4" I.D. Tube Sample MC - 3" O.D. 2.4" I.D. Ring Sample NR - No Recovery * - Uncorrected Blow Counts		Depth (ft)	Hour	Date
										Visual Classification				
0										TOPSOIL 0.2' Topsoil (Approximately 2 inches)				
				SPT- 1	2-4-2 N60=9				SM	Loose brown fine to medium silty sand (SM) with rock fragments and trace organics (RESIDUUM)				
				SPT- 2	23-19-28 N60=67				SM	Very dense white fine to coarse silty sand (SM) with rock fragments				
5				SPT- 3	29-50/4 N60=100				PWR	Partially weathered rock sampled as white fine to coarse silty sand (SM)				
										8.0'				

Notes:
Auger refusal at approx. depth of 8.0 feet.
Cave in at 4.5 feet

Date	Started: 11/29/23		Project Number 121-23-113900		Project Wake Tech Fire & Rescue		Boring No. B-7							
	Completed: 11/29/23													
	Hammer Type: Automatic		Drilling Method: HSA		Logged By: JGD		Reviewed By: BPH							
Latitude:		Longitude:		Surface Elevation:										
Groundwater Depth (ft.)	Depth (ft.)	Graphical Log	Sample Taken	Sample ID	SPT N-Value	Moisture Content (%)	% Passing No. 200	Other Tests and Remarks	USCS Class.	Location: See Figure 1				
										Sample Type		Groundwater		
										G - Bulk / Grab Sample SPT - 2" O.D. 1.4" I.D. Tube Sample MC - 3" O.D. 2.4" I.D. Ring Sample NR - No Recovery * - Uncorrected Blow Counts		Depth (ft)	Hour	Date
										Visual Classification				
0										0.1' Topsoil (Approximately 1 inch)				
				SPT- 1	4-2-2 N60=6				SM	Loose brown fine to medium silty sand (SM)				
										3.0'				
				SPT- 2	50/0.5 N60=100				PWR	Partially weathered rock sampled as gray fine to medium silty sand (SM)				
5										5.0'				

Notes:

Auger refusal at approx. depth of 5.0 feet.
Cave in at 4 feet

Date	Started: 12/1/23			Project Number 121-23-113900				Project Wake Tech Fire & Rescue				Boring No. B-8								
	Completed: 12/1/23																			
	Hammer Type: Automatic			Drilling Method: HSA				Logged By: JGD				Reviewed By: BPH								
Latitude:				Longitude:				Surface Elevation:												
Groundwater Depth (ft.)	Depth (ft.)	Graphical Log Sample Taken	Sample ID	SPT N-Value	Moisture Content (%)	% Passing No. 200	Other Tests and Remarks	USCS Class.	Location: See Figure 1											
									Sample Type G - Bulk / Grab Sample SPT - 2" O.D. 1.4" I.D. Tube Sample MC - 3 " O.D. 2.4" I.D. Ring Sample NR - No Recovery * - Uncorrected Blow Counts		Groundwater									
											Depth (ft)	Hour	Date							
																	Visual Classification			
0									0.2'	Topsoil (Apprxoximately 2 inches)										
				SPT- 1	3-3-3 N60=9			SM		Loose gray fine to medium silty sand (SM) (RESIDUUM)										
									3.0'											
				SPT- 2	4-5-6 N60=16			ML		Very stiff gray brown black fine to medium sandy silt (ML)										
5									5.5'											
				SPT- 3	5-6-8 N60=20			SM		Firm tran gray fine to medium silty sand (SM)										
									8.0'											
				SPT- 4	33-50/5 N60=100					Partially weathered rock sampled as brown fine to medium silty sand (SM)										
10								PWR												
				SPT- 5	50/0 N60=100					13.5'										

Notes:
Auger refusal at approx. depth of 13.5 feet.
Cave in at 9.5 feet

Date	Started: 11/29/23		Project Number 121-23-113900		Project Wake Tech Fire & Rescue			Boring No. B-9					
	Completed: 11/29/23												
	Hammer Type: Automatic		Drilling Method: HSA			Logged By: JGD		Reviewed By: BPH					
Latitude:			Longitude:			Surface Elevation:							
Groundwater Depth (ft.)	Depth (ft.)	Graphical Log	Sample Taken	Sample ID	SPT N-Value	Moisture Content (%)	% Passing No. 200	Other Tests and Remarks	USCS Class.	Location: See Figure 1			
										Sample Type G - Bulk / Grab Sample SPT - 2" O.D. 1.4" I.D. Tube Sample MC - 3" O.D. 2.4" I.D. Ring Sample NR - No Recovery * - Uncorrected Blow Counts	Groundwater		
											Depth (ft)	Hour	Date
											Visual Classification		
0										0.2' Topsoil (Approximately 2 inches)			
				SPT- 1	2-1-1 N60=3				SM	Very loose brown fine to medium silty sand (SM) (RESIDUUM)			
				SPT- 2	3-2-5 N60=10				ML	Stiff orange brown gray fine to medium sandy silt (ML)			
5				SPT- 3	29-13-19 N60=46				CL	Hard brown gray silty clay (CL) with rock fragments			
				SPT- 4	10-15-17 N60=46				ML	Hard brown orange fine to coarse sandy silt (ML)			
10													
				SPT- 5	WOH-1-1 N60=3				ML	Soft brown fine to medium sandy silt (ML)			
15													
				SPT- 6	WOH-2-3 N60=7				SM	Loose to firm brown fine to medium silty sand (SM)			
20													
				SPT- 7	6-7-7 N60=20								
25													

Notes:
Boring terminated at approx. depth of 25.0 feet.
Cave in at 19.5 feet

Date	Started: 12/1/23		Project Number 121-23-113900		Project Wake Tech Fire & Rescue		Boring No. B-10							
	Completed: 12/1/23													
	Hammer Type: Automatic		Drilling Method: HSA		Logged By: JGD		Reviewed By: BPH							
Latitude:		Longitude:		Surface Elevation:										
Groundwater Depth (ft.)	Depth (ft.)	Graphical Log	Sample Taken	Sample ID	SPT N-Value	Moisture Content (%)	% Passing No. 200	Other Tests and Remarks	USCS Class.	Location: See Figure 1				
										Sample Type		Groundwater		
										G - Bulk / Grab Sample SPT - 2" O.D. 1.4" I.D. Tube Sample MC - 3" O.D. 2.4" I.D. Ring Sample NR - No Recovery * - Uncorrected Blow Counts		Depth (ft)	Hour	Date
										Visual Classification				
0										0.2'	Topsoil (Approximately 2 inches)			
				SPT- 1	1-4-3 N60=10				CL		Stiff gray fine to medium sandy clay (CL) with trace organics (RESIDUUM)			
										3.0'				
				SPT- 2	3-5-7 N60=17				CL		Very stiff brown tan silty clay (CL)			
5										5.5'				
				SPT- 3	23-20-30 N60=71				SM		Very dense brown tan fine to coarse silty sand (SM)			
										8.0'				
				SPT- 4	7-10-50/6 N60=100									
10									PWR		Partially weathered rock sampled as brown tan black fine to medium silty sand (SM)			
				SPT- 5	18-39-33 N60=100									
15										16.5'				

Notes:
Auger refusal at approx. depth of 16.5 feet.
Cave in at 14 feet

Date	Started: 11/29/23		Project Number 121-23-113900		Project Wake Tech Fire & Rescue			Boring No. B-11					
	Completed: 11/29/23												
	Hammer Type: Automatic		Drilling Method: HSA			Logged By: JGD		Reviewed By: BPH					
Latitude:			Longitude:			Surface Elevation:							
Groundwater Depth (ft.)	Depth (ft.)	Graphical Log	Sample Taken	Sample ID	SPT N-Value	Moisture Content (%)	% Passing No. 200	Other Tests and Remarks	USCS Class.	Location: See Figure 1			
										Sample Type G - Bulk / Grab Sample SPT - 2" O.D. 1.4" I.D. Tube Sample MC - 3" O.D. 2.4" I.D. Ring Sample NR - No Recovery * - Uncorrected Blow Counts	Groundwater		
											Depth (ft)	Hour	Date
											15.5		
Visual Classification													

0										0.1' Topsoil (Approximately 1 inches)
				SPT- 1	2-5-5 N60=14					
									CL	Stiff to firm brown gray fine to medium sandy clay (CL) with trace organics (RESIDUUM)
5				SPT- 2	2-2-2 N60=6					5.5'
				SPT- 3	WOH N60=0				MH	Very soft brown gray clayey silt (MH)
10										12.0'
				SPT- 4	WOH-1-1 N60=3					
15										
				SPT- 5	WOH-1-2 N60=4				MH	Soft red tan clayey silt (MH)
20										
				SPT- 6	WOH- WOH-2 N60=3					
25										25.0'

Notes:
Boring terminated at approx. depth of 25.0 feet.
Groundwater at 15.5 feet and Cave in at 17.5 feet

Date	Started: 11/28/23		Project Number 121-23-113900		Project Wake Tech Fire & Rescue		Boring No. B-12							
	Completed: 11/28/23													
	Hammer Type: Automatic		Drilling Method: HSA		Logged By: JGD		Reviewed By: BPH							
Latitude:		Longitude:		Surface Elevation:										
Groundwater Depth (ft.)	Depth (ft.)	Graphical Log	Sample Taken	Sample ID	SPT N-Value	Moisture Content (%)	% Passing No. 200	Other Tests and Remarks	USCS Class.	Location: See Figure 1				
										Sample Type		Groundwater		
										G - Bulk / Grab Sample SPT - 2" O.D. 1.4" I.D. Tube Sample MC - 3" O.D. 2.4" I.D. Ring Sample NR - No Recovery * - Uncorrected Blow Counts		Depth (ft)	Hour	Date
										Visual Classification				
0										0.1'	Topsoil (Approximately 1 inch)			
				SPT- 1	4-2-2 N60=6				ML		Firm brown black fine to medium sandy silt (ML) (RESIDUUM)			
										3.0'				
				SPT- 2	2-3-5 N60=11				ML		Stiff brown red fine to medium micaceous sandy silt (ML) with trace organics			
										5.5'				
				SPT- 3	4-6-7 N60=19									
				SPT- 4	6-7-7 N60=20				SM		Firm brown red fine to medium micaceous silty sand (SM)			
										12.0'				
				SPT- 5	10-22-50/5 N60=100				PWR		Partially weathered rock sampled as brown red fine to medium micaceous silty sand (SM)			
										15.0'				

Notes:
Boring terminated at approx. depth of 15.0 feet.
Cave in at 11.5 feet

Date	Started: 11/28/23		Project Number 121-23-113900		Project Wake Tech Fire & Rescue		Boring No. B-13							
	Completed: 11/28/23													
	Hammer Type: Automatic		Drilling Method: HSA		Logged By: JGD		Reviewed By: BPH							
Latitude:		Longitude:		Surface Elevation:										
Groundwater Depth (ft.)	Depth (ft.)	Graphical Log	Sample Taken	Sample ID	SPT N-Value	Moisture Content (%)	% Passing No. 200	Other Tests and Remarks	USCS Class.	Location: See Figure 1				
										Sample Type		Groundwater		
										G - Bulk / Grab Sample SPT - 2" O.D. 1.4" I.D. Tube Sample MC - 3" O.D. 2.4" I.D. Ring Sample NR - No Recovery * - Uncorrected Blow Counts		Depth (ft)	Hour	Date
										Visual Classification				
0										TOPSOIL	0.2'	Topsoil (Approximately 2 inches)		
				SPT- 1	3-7-29 N60=51					SM		Very dense brown fine to coarse silty sand (SM) with trace organics and rock fragments (RESIDUUM)		
											3.0'			
				SPT- 2	50/5 N60=100					PWR		Partially weathered rock sampled as white tan fine to coarse silty sand (SM)		
5											5.5'			

Notes:
Auger refusal at approx. depth of 5.5 feet.

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Notes:

Boring terminated at approx. depth of 20.0 feet.
Groundwater at 9 feet and Cave in at 10 feet

Date	Started: 12/1/23		Project Number 121-23-113900		Project Wake Tech Fire & Rescue		Boring No. B-15							
	Completed: 12/1/23													
	Hammer Type: Automatic		Drilling Method: HSA		Logged By: JGD		Reviewed By: BPH							
Latitude:		Longitude:		Surface Elevation:										
Groundwater Depth (ft.)	Depth (ft.)	Graphical Log	Sample Taken	Sample ID	SPT N-Value	Moisture Content (%)	% Passing No. 200	Other Tests and Remarks	USCS Class.	Location: See Figure 1				
										Sample Type		Groundwater		
										G - Bulk / Grab Sample SPT - 2" O.D. 1.4" I.D. Tube Sample MC - 3" O.D. 2.4" I.D. Ring Sample NR - No Recovery * - Uncorrected Blow Counts		Depth (ft)	Hour	Date
										Visual Classification				
0										0.1' Topsoil (Approximately 1 inch)				
				SPT- 1	4-2-4 N60=9				ML	Stiff brown tan fine to medium sandy silt (ML) (RESIDUUM)				
				SPT- 2	22-50/2 N60=100				PWR	Partially weathered rock sampled as tan fine to medium silty sand (SM)				
5				SPT- 3	27-15-16 N60=44					5.5'				
				SPT- 4	39-17-19 N60=51				SM	Dense and very dense brown tan fine to medium silty sand (SM)				
10				SPT- 5	15-17-17 N60=48					15.0'				
15														

Notes:
Boring terminated at approx. depth of 15.0 feet.
Cave in at 11 feet

Date	Started: 11/29/23		Project Number 121-23-113900		Project Wake Tech Fire & Rescue		Boring No. B-16							
	Completed: 11/29/23													
	Hammer Type: Automatic		Drilling Method: HSA		Logged By: JGD		Reviewed By: BPH							
Latitude:		Longitude:		Surface Elevation:										
Groundwater Depth (ft.)	Depth (ft.)	Graphical Log	Sample Taken	Sample ID	SPT N-Value	Moisture Content (%)	% Passing No. 200	Other Tests and Remarks	USCS Class.	Location: See Figure 1				
										Sample Type		Groundwater		
										G - Bulk / Grab Sample SPT - 2" O.D. 1.4" I.D. Tube Sample MC - 3" O.D. 2.4" I.D. Ring Sample NR - No Recovery * - Uncorrected Blow Counts		Depth (ft)	Hour	Date
Visual Classification														
0										0.1' Topsoil (Approximately 1 inch)				
				SPT- 1	3-4-4 N60=11				ML	Stiff brown fine to medium sandy silt (ML) with trace organics (RESIDUUM)				
										3.0'				
5				SPT- 2	4-5-7 N60=17				ML	Very stiff brown orange fine to medium sandy silt (ML)				
				SPT- 3	3-7-9 N60=23									
										8.0'				
				SPT- 4	4-5-8 N60=19				SM	Firm brown orange micaceous fine to medium silty sand (SM)				
10										10.0'				

Notes:
Boring terminated at approx. depth of 10.0 feet.
Cave in at 7 feet

Date	Started: 11/28/23		Project Number 121-23-113900		Project Wake Tech Fire & Rescue		Boring No. B-17							
	Completed: 11/28/23													
	Hammer Type: Automatic		Drilling Method: HSA		Logged By: JGD		Reviewed By: BPH							
Latitude:		Longitude:		Surface Elevation:										
Groundwater Depth (ft.)	Depth (ft.)	Graphical Log	Sample Taken	Sample ID	SPT N-Value	Moisture Content (%)	% Passing No. 200	Other Tests and Remarks	USCS Class.	Location: See Figure 1				
										Sample Type		Groundwater		
										G - Bulk / Grab Sample SPT - 2" O.D. 1.4" I.D. Tube Sample MC - 3" O.D. 2.4" I.D. Ring Sample NR - No Recovery * - Uncorrected Blow Counts		Depth (ft)	Hour	Date
										Visual Classification				
0										0.1' Topsoil (Approximately 1 inch)				
				SPT- 1	4-4-7 N60=16				ML	Very stiff brown fine to medium micaceous sandy silt (ML) (RESIDUUM)				
5				SPT- 2	WOH-1-2 N60=4					3.0'				
				SPT- 3	2-1-2 N60=4				SM	Very loose red brown tan fine to medium micaceous silty sand (SM)				
10				SPT- 4	2-1-1 N60=3					10.0'				

Notes:
Boring terminated at approx. depth of 10.0 feet.
Cave in at 7 feet

Date	Started: 11/28/23		Project Number 121-23-113900		Project Wake Tech Fire & Rescue		Boring No. B-18							
	Completed: 11/28/23													
	Hammer Type: Automatic		Drilling Method: HSA		Logged By: JGD		Reviewed By: BPH							
Latitude:		Longitude:		Surface Elevation:										
Groundwater Depth (ft.)	Depth (ft.)	Graphical Log	Sample Taken	Sample ID	SPT N-Value	Moisture Content (%)	% Passing No. 200	Other Tests and Remarks	USCS Class.	Location: See Figure 1				
										Sample Type		Groundwater		
										G - Bulk / Grab Sample SPT - 2" O.D. 1.4" I.D. Tube Sample MC - 3" O.D. 2.4" I.D. Ring Sample NR - No Recovery * - Uncorrected Blow Counts		Depth (ft)	Hour	Date
Visual Classification														
0										0.1'	Topsoil (Approximately 1 inch)			
				SPT- 1	3-3-5 N60=11				CL		Stiff red brown fine to medium micaceous sandy clay (CL)			
										3.0'				
5				SPT- 2	4-6-7 N60=19									
				SPT- 3	2-6-6 N60=17				SM		Firm to very firm red brown tan fine to medium micaceous silty sand (SM)			
				SPT- 4	6-9-10 N60=27									
10										10.0'				

Notes:
Boring terminated at approx. depth of 10.0 feet.
Cave in at 7 feet

Date	Started: 12/1/23		Project Number 121-23-113900		Project Wake Tech Fire & Rescue		Boring No. B-19							
	Completed: 12/1/23													
	Hammer Type: Automatic		Drilling Method: HSA		Logged By: JGD		Reviewed By: BPH							
Latitude:		Longitude:		Surface Elevation:										
Groundwater Depth (ft.)	Depth (ft.)	Graphical Log	Sample Taken	Sample ID	SPT N-Value	Moisture Content (%)	% Passing No. 200	Other Tests and Remarks	USCS Class.	Location: See Figure 1				
										Sample Type		Groundwater		
										G - Bulk / Grab Sample SPT - 2" O.D. 1.4" I.D. Tube Sample MC - 3" O.D. 2.4" I.D. Ring Sample NR - No Recovery * - Uncorrected Blow Counts		Depth (ft)	Hour	Date
										Visual Classification				
0										0.2'	Topsoil (Approximately 2 inches)			
				SPT- 1	4-4-4 N60=11				SM		Firm brown fine to medium silty sand (SM) with rock fragments (RESIDUUM)			
										3.0'				
5				SPT- 2	20-34-50/5 N60=100				PWR		Partially weathered rock sampled as red tan fine to medium silty sand (SM)			
										6.5'				

Notes:
Auger refusal at approx. depth of 6.5 feet.
Cave in at 5 feet

Date	Started: 11/29/23		Project Number 121-23-113900		Project Wake Tech Fire & Rescue			Boring No. B-20					
	Completed: 11/29/23												
	Hammer Type: Automatic		Drilling Method: HSA			Logged By: JGD		Reviewed By: BPH					
Latitude:			Longitude:			Surface Elevation:							
Groundwater Depth (ft.)	Depth (ft.)	Graphical Log	Sample Taken	Sample ID	SPT N-Value	Moisture Content (%)	% Passing No. 200	Other Tests and Remarks	USCS Class.	Location: See Figure 1			
										Sample Type G - Bulk / Grab Sample SPT - 2" O.D. 1.4" I.D. Tube Sample MC - 3" O.D. 2.4" I.D. Ring Sample NR - No Recovery * - Uncorrected Blow Counts	Groundwater		
											Depth (ft)	Hour	Date
											Visual Classification		
0										0.1' Topsoil (Approximately 1 inch)			
				SPT- 1	2-1-2 N60=4				ML	Soft brown orange fine to medium sandy silt (ML) (RESIDUUM)			
				SPT- 2	4-5-6 N60=16				ML	Very stiff brown orange fine to medium sandy silt (ML)			
				SPT- 3	3-6-8 N60=20								
5				SPT- 4	30-41-28 N60=98				SM	Very dense brown orange fine to medium silty sand (SM)			
10										10.0'			

Notes:

Boring terminated at approx. depth of 10.0 feet.

Cave in at 5.5 feet

Date	Started: 11/29/23		Project Number 121-23-113900		Project Wake Tech Fire & Rescue			Boring No. B-21					
	Completed: 11/29/23												
	Hammer Type: Automatic		Drilling Method: HSA			Logged By: JGD		Reviewed By: BPH					
Latitude:			Longitude:			Surface Elevation:							
Groundwater Depth (ft.)	Depth (ft.)	Graphical Log	Sample Taken	Sample ID	SPT N-Value	Moisture Content (%)	% Passing No. 200	Other Tests and Remarks	USCS Class.	Location: See Figure 1			
										Sample Type G - Bulk / Grab Sample SPT - 2" O.D. 1.4" I.D. Tube Sample MC - 3" O.D. 2.4" I.D. Ring Sample NR - No Recovery * - Uncorrected Blow Counts	Groundwater		
											Depth (ft)	Hour	Date
											Visual Classification		
0										0.2' Topsoil (Approximately 2 inches)			
				SPT- 1	3-3-3 N60=9				SM	Loose tan orange fine to medium silty sand (SM) (RESIDUUM)			
5				SPT- 2	5-8-7 N60=21								
				SPT- 3	4-4-6 N60=14				ML	Stiff and very stiff tan orange fine to medium sandy silt (ML)			
10				SPT- 4	5-6-5 N60=16								
										10.0'			

Notes:
Boring terminated at approx. depth of 10.0 feet.
Cave in at 5 feet

Date	Started: 12/1/23		Project Number 121-23-113900		Project Wake Tech Fire & Rescue			Boring No. B-22					
	Completed: 12/1/23												
	Hammer Type: Automatic		Drilling Method: HSA			Logged By: JGD		Reviewed By: BPH					
Latitude:			Longitude:			Surface Elevation:							
Groundwater Depth (ft.)	Depth (ft.)	Graphical Log	Sample Taken	Sample ID	SPT N-Value	Moisture Content (%)	% Passing No. 200	Other Tests and Remarks	USCS Class.	Location: See Figure 1			
										Sample Type G - Bulk / Grab Sample SPT - 2" O.D. 1.4" I.D. Tube Sample MC - 3" O.D. 2.4" I.D. Ring Sample NR - No Recovery * - Uncorrected Blow Counts	Groundwater		
											Depth (ft)	Hour	Date
											Visual Classification		
0										0.1' Topsoil (Approximately 1 inch)			
				SPT- 1	2-3-4 N60=10				SM	Loose brown fine to medium silty sand (SM) (RESIDUUM)			
				SPT- 2	4-6-6 N60=17				CL	Very stiff orange gray silty clay (CL) with trace organics			
5				SPT- 3	3-3-4 N60=10				ML	Stiff orange brown fine to medium sandy silt (ML)			
				SPT- 4	3-4-3 N60=10								
10										10.0'			

Notes:

Boring terminated at approx. depth of 10.0 feet.
Cave in at 7.5 feet

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. Owner-furnished/Contractor-installed (OFICI) products.
- 4. Owner-furnished/Owner-installed (OFOI) products.
- 5. Contractor-furnished/Owner-installed (CFOI) products.
- 6. Contractor's use of site and premises.
- 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.
- 2. Section 017300 "Execution" for coordination of Owner-installed products.

1.3 PROJECT INFORMATION

- A. Project Identification: Eastern Wake Site – Fire & Rescue Training Center.

- 1. Project Location: Wake Technical Community College, 5345 Rolesville Rd, Wendell, NC.

- B. Owner: Wake Technical Community College.

- 1. Owner's Representative: Walter Lennon, 919.866.6152. Wake Technical Community College, 4723 Advantage Way, Bldg. T, Raleigh, NC, 27603.

- C. Architect: HH Architecture, 1100 Dresser Court, 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 O'Brien, 702 Oberlin Road, Suite 300, Raleigh, NC 27605.
 2. Structural Engineer: Lynch Mykins, 301 N West Street, Suite 105, Raleigh, NC 27616.
 3. Fire Training Structural Engineer: 8001 Forbes Place #201, Springfield, VA 22151
 4. Civil Engineer: NV5 Engineers & Consultants, Inc., 3300 Regency Parkway, Cary, NC 27518.
 5. Landscape Architect: Surface 678, 215 Morris St, Suite 150, Durham, NC 27701.
 6. Geotechnical: S&ME, 3201 Spring Forest Rd, Raleigh, NC 27616.
- E. Construction Manager:
1. Construction Manager has been selected by the owner during this process. Samet Corporation, 5430 Wade Park Blvd, Suite 110, Raleigh, NC 27607 has been selected by the owner.
 2. Construction Manager for this Project is Project's constructor. The terms "Construction Manager" and "Contractor" are synonymous.
- F. Other Owner Consultants: The Owner has retained the following design professionals who have prepared designated portions of the Contract Documents:
- a. CMT/Special Inspections: To Be Determined
 - b. Commissioning Agent: RMF Engineering
 - c. Structural/Civil Peer Review: SKA Consulting Engineers
 - d. Photographic Documentation: Multivista Systems LLC
- G. Principle Trade and Specialty Contractors: As contracted to the General Contractor through public procurement in accordance with the General Statutes of the State of North Carolina. The terms "Principle Trade and Specialty Contractor" and "Contractor" are synonymous.
- H. Web-Based Project Software: Project software will be used for purposes of managing communication and documents during the construction stage.
1. See Section 013100 "Project Management and Coordination." for requirements for using web-based Project software.

1.4 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project is defined by the Contract Documents and includes, but is not limited to, the following:

Wake Technical Community College (WTCC) is undertaking the creation of a new dedicated fire and rescue training center to support the specialized training requirement of the fire and rescue community of wake county and the surrounding region. The new center will be located on the recently constructed Eastern Wake Site (EWS) in Wendell, NC. this new facility expands and enhances the college's public safety educational programs.

The primary focus of the new fire and rescue training center is to provide specialized training facilities that can be used to prepare students and recruits for real-world emergency scenarios. The center will also be used to support active first responders in maintaining certifications and updated training as the response to various emergency situations evolves.

The development of the training grounds will provide areas that support the various training props. The project's priority will begin with the Burn Building (a live fire training structure) and the Training Tower. These multi-story structures are built to provide variable training conditions under live burn conditions and to simulate elevated technical rescue circumstances.

Ancillary structures to support the training functions include a shade structure with showers and toilet rooms and a covered open-air storage structure for burn materials.

- B. Type of Contract:
1. Project will be constructed under a single prime Construction Manager at Risk contract in accordance with the State of North Carolina's requirements.

1.5 WORK UNDER OWNER'S SEPARATE CONTRACTS

- A. Work with Separate Contractors: Cooperate fully with Owner's 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 Owner's separate contracts.

1.6 OWNER-FURNISHED/CONTRACTOR-INSTALLED (OFCI) PRODUCTS

- A. Owner's Responsibilities: Owner will furnish products indicated and perform the following, as applicable:
1. Provide to Contractor Owner-reviewed Product Data, Shop Drawings, and Samples.
 2. Provide for delivery of Owner-furnished products to Project site.
 3. Upon delivery, inspect, with Contractor present, delivered items.
 - a. If Owner-furnished products are damaged, defective, or missing, arrange for replacement.
 4. Obtain manufacturer's inspections, service, and warranties.
 5. Inform Contractor of earliest available delivery date for Owner-furnished products.
- B. Contractor's Responsibilities: The Work includes the following, as applicable:
1. Designate delivery dates of Owner-furnished products in Contractor's construction schedule, utilizing Owner-furnished earliest available delivery dates.
 2. Review Owner-reviewed Product Data, Shop Drawings, and Samples, noting discrepancies and other issues in providing for Owner-furnished products in the Work.
 3. Receive, unload, handle, store, protect, and install Owner-furnished products.
 4. Make building services connections for Owner-furnished products.

5. Protect Owner-furnished products from damage during storage, handling, and installation and prior to Substantial Completion.
6. Repair or replace Owner-furnished products damaged following receipt.

C. Owner-Furnished/Contractor-Installed (OFCI) Products:

1. EV Charging Stations.

1.7 ACCESS TO SITE

- A. Unrestricted Use of Site: Each Contractor shall have full use of Project site for construction operations during construction period, in accordance with the requirements of the General Contractor. 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. Limits on 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 on Use of Site: Confine construction operations to Area of Disturbance as defined on drawings.

1.8 WORK RESTRICTIONS

- A. Comply with restrictions on construction operations.
 1. Comply with limitations on use of public streets, work on public streets, rights of way, and 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.
 1. Early Morning Hours: In accordance with Wake Technical Community College.
- C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging for temporary utility services according to requirements indicated:
 1. Notify General Contractor not less than two days, or as required by the Utility owner, in advance of proposed utility interruptions
 2. Obtain General Contractor written permission before proceeding with utility interruptions.
- D. Noise, Vibration, Dust, and Odors: Coordinate operations that may result in high levels of noise and vibration, dust, odors, or other disruption to Owner occupancy with Owner.
 1. Notify General Contractor not less than two days in advance of proposed disruptive operations.
 2. Obtain General Contractor written permission before proceeding with disruptive operations.

- E. Smoking and Controlled Substance Restrictions: Use of tobacco products, alcoholic beverages, and other controlled substances on Project site or on Owner's property is not permitted.
- F. Employee Identification: Provide identification tags for Contractor personnel working on Project site. Require personnel to use identification tags at all times.
- G. 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.

1.9 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.
- B. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- C. Division 00 Contracting Requirements: General provisions of the Contract, including General and Supplementary Conditions, apply to all Sections of the Specifications.
- D. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- E. 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 scheduled on Drawings and published as part of the U.S. National CAD Standard.
 - 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 012100 - ALLOWANCES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements governing allowances.
- B. Types of allowances include the following:
 - 1. Lump-sum allowances.
 - 2. Unit-cost allowances.
- C. Related Requirements:
 - 1. Section 012200 "Unit Prices" for procedures for using unit prices, including adjustment of quantity allowances when applicable.
 - 2. Section 012600 "Contract Modification Procedures" for procedures for submitting and handling Change Orders.
 - 3. Section 014000 "Quality Requirements" for procedures governing the use of allowances for field testing by an independent testing agency.

1.2 ACTION SUBMITTALS

- A. Submit proposals for purchase of products or systems included in allowances in the form specified for Change Orders.

1.3 INFORMATIONAL SUBMITTALS

- A. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.
- B. Coordinate and process submittals for allowance items in same manner as for other portions of the Work.

1.4 LUMP-SUM ALLOWANCES

- A. Allowance shall include cost to Contractor of specific products and materials ordered by Owner or selected by Architect under allowance and shall include taxes, freight, and delivery to Project site.
- B. Unless otherwise indicated, Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials ordered by Owner or selected by Architect under allowance shall be included as part of the Contract Sum and not part of the allowance.

- C. Unused Materials: Return unused materials purchased under an allowance to manufacturer or supplier for credit to Owner, after installation has been completed and accepted.
 - 1. If requested by Architect, retain and prepare unused material for storage by Owner. Deliver unused material to Owner's storage space as directed.

1.5 UNIT-COST ALLOWANCES

- A. Allowance shall include cost to Contractor of specific products and materials ordered by Owner or selected by Architect under allowance and shall include taxes, freight, and delivery to Project site.
- B. Unless otherwise indicated, Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials ordered by Owner or selected by Architect under allowance shall be included as part of the Contract Sum and not part of the allowance.
- C. Unused Materials: Return unused materials purchased under an allowance to manufacturer or supplier for credit to Owner, after installation has been completed and accepted.
 - 1. If requested by Architect, retain and prepare unused material for storage by Owner. Deliver unused material to Owner's storage space as directed.

1.6 QUANTITY ALLOWANCES

- A. Allowance shall include cost to Contractor of specific products and materials ordered by Owner or selected by Architect under allowance and shall include taxes, freight, and delivery to Project site.
- B. Unless otherwise indicated, Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials ordered by Owner or selected by Architect under allowance shall be included as part of the Contract Sum and not part of the allowance.
- C. Unused Materials: Return unused materials purchased under an allowance to manufacturer or supplier for credit to Owner, after installation has been completed and accepted.
 - 1. If requested by Architect, retain and prepare unused material for storage by Owner. Deliver unused material to Owner's storage space as directed.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

3.2 PREPARATION

- A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

3.3 SCHEDULE OF ALLOWANCES

- A. Allowance No. A: Unsuitable Soil – On-Site Disposal and Backfill with On-Site Suitable Soils.
 - 1. Description: Removal of unsuitable soil, disposal of unsuitable soil for re-use on-site, and replacement of unsuitable soil and/or debris with a controlled backfill material from an on-site source.
 - 2. Unit Price includes excavation, transportation, re-spread, compaction, and backfill to compaction requirements per specifications.
 - 3. This allowance includes material cost receiving, handling, and installation and Contractor overhead and profit.
 - 4. Allowance Quantity: 100 cubic yards.
 - 5. Base Bid Quantity: Lump sum.
- B. Allowance No. B: Unsuitable Soil – On-site disposal and Backfill with off Site Source Suitable Soils.
 - 1. Description: Removal of unsuitable soil, disposal for re-use on-site, and replacement of unsuitable soil and/or debris with a controlled backfill material from an off-site source.
 - 2. Unit Price includes excavation, transportation, re-spread, compaction, and backfill to compaction requirements per specifications.
 - 3. This allowance includes material cost receiving, handling, and installation and Contractor overhead and profit.
 - 4. Allowance Quantity: 100 cubic yards.
 - 5. Base Bid Quantity: Lump sum.
- C. Allowance No. C: Unsuitable soil – Off-site disposal and Backfill with On-Site Source Suitable Soils.
 - 1. Description: Removal, disposal off-site, and replacement of unsuitable soil and/or debris with a controlled backfill material from an on-site source.
 - 2. Unit Price includes excavation, transportation, re-spread, compaction, and backfill to compaction requirements per specifications.
 - 3. This allowance includes material cost receiving, handling, and installation and Contractor overhead and profit.
 - 4. Allowance Quantity: 50 cubic yards.

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5. Base Bid Quantity: Lump sum.
- D. Allowance No. D: Unsuitable Soil – Off-site disposal and Backfill with Off-Site Source Suitable Soils.
1. Description: Removal, disposal off-site, and replacement of unsuitable soil and/or debris with a controlled backfill material from an off-site source.
 2. Unit Price includes excavation, transportation, re-spread, compaction, and backfill to compaction requirements per specifications.
 3. This allowance includes material cost receiving, handling, and installation and Contractor overhead and profit.
 4. Allowance Quantity: 50 cubic yards.
 5. Base Bid Quantity: Lump sum.
- E. Allowance No. E: Unsuitable Trench Soil – On-site disposal and Backfill with On-Site Suitable Soils.
1. Description: Removal of unsuitable soil, disposal of unsuitable soil for re-use on-site, and replacement of unsuitable soil and/or debris with a controlled backfill material from an on-site source.
 2. Unit Price includes excavation, transportation, re-spread, compaction, and backfill to compaction requirements per specifications.
 3. This allowance includes material cost receiving, handling, and installation and Contractor overhead and profit.
 4. Allowance Quantity: 50 cubic yards.
 5. Base Bid Quantity: Lump sum.
 6. .
- F. Allowance No. F: Unsuitable Trench Soil – On-Site Disposal and Backfill with Off Site Source Suitable Soils.
1. Description: Removal of unsuitable soil, disposal for re-use on-site, and replacement of unsuitable soil and/or debris with a controlled backfill material from an off-site source.
 2. Unit Price includes excavation, transportation, re-spread, compaction, and backfill to compaction requirements per specifications.
 3. This allowance includes material cost receiving, handling, and installation and Contractor overhead and profit.
 4. Allowance Quantity: 50 cubic yards.
 5. Base Bid Quantity: Lump sum.
- G. Allowance No. G: Unsuitable Trench Soil – Off-Site Disposal and Backfill With On-Site Source Suitable Soils.
1. Description: Removal unsuitable soil, disposal off-site, and replacement of unsuitable soil and/or debris with a controlled backfill material from an on-site source.
 2. Unit Price includes excavation, transportation, re-spread, compaction, and backfill to compaction requirements per specifications.
 3. This allowance includes material cost receiving, handling, and installation and Contractor overhead and profit.
 4. Allowance Quantity: 50 cubic yards.
 5. Base Bid Quantity: Lump sum.

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- H. Allowance No. H: Unsuitable Trench Soil – Off-Site Disposal and Backfill with Off-Site Source Suitable Soils.
1. Description: Removal, disposal off-site, and replacement of unsuitable soil and/or debris with a controlled backfill material from an off-site source.
 2. Unit Price includes excavation, transportation, re-spread, compaction, and backfill to compaction requirements per specifications.
 3. This allowance includes material cost receiving, handling, and installation and Contractor overhead and profit.
 4. Allowance Quantity: 50 cubic yards.
 5. Base Bid Quantity: Lump sum.

END OF SECTION 012100

SECTION 012200 - UNIT PRICES

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 unit prices.
- B. Related Requirements:
 - 1. Section 012100 "Allowances" for procedures for using unit prices to adjust quantity allowances.
 - 2. Section 012600 "Contract Modification Procedures" for procedures for submitting and handling Change Orders.
 - 3. Section 014000 "Quality Requirements" for field testing by an independent testing agency.

1.3 DEFINITIONS

- A. Unit price is an amount incorporated into the Agreement, applicable during the duration of the Work as a price per unit of measurement for materials, equipment, or services, or a portion of the Work, added to or deducted from the Contract Sum by appropriate modification, if the scope of Work or estimated quantities of Work required by the Contract Documents are increased or decreased.

1.4 PROCEDURES

- A. Unit prices include all necessary material, plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.
- B. Measurement and Payment: See individual Specification Sections for work that requires establishment of unit prices. Methods of measurement and payment for unit prices are specified in those Sections.
- C. Owner reserves the right to reject Contractor's measurement of work-in-place that involves use of established unit prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.

- D. List of Unit Prices: A schedule of unit prices is included in Part 3. Specification Sections referenced in the Part 3 "Schedule of Unit Prices" Article contain requirements for materials described under each unit price.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF UNIT PRICES

- A. Allowance No. A: Unsuitable Soil – On-Site Disposal and Backfill with On-Site Suitable Soils. As referenced in Section 012100 "Allowances", Part 3.3.
1. Description: Removal of unsuitable soil, disposal of unsuitable soil for re-use on-site, and replacement of unsuitable soil and/or debris with a controlled backfill material from an on-site source.
 2. Unit Price includes excavation, transportation, re-spread, compaction, and backfill to compaction requirements per specifications.
 3. Quantity Allowance: Coordinate unit price with allowance adjustment requirements in Section 012100 "Allowances."
- B. Allowance No. B: Unsuitable Soil – On-site disposal and Backfill with off Site Source Suitable Soils. As referenced in Section 012100 "Allowances", Part 3.3.
1. Description: Removal of unsuitable soil, disposal for re-use on-site, and replacement of unsuitable soil and/or debris with a controlled backfill material from an off-site source.
 2. Unit Price includes excavation, transportation, re-spread, compaction, and backfill to compaction requirements per specifications.
 3. This allowance includes material cost receiving, handling, and installation and Contractor overhead and profit.
 4. Quantity Allowance: Coordinate unit price with allowance adjustment requirements in Section 012100 "Allowances."
- C. Allowance No. C: Unsuitable soil – Off-site disposal and Backfill with On-Site Source Suitable Soils. As referenced in Section 012100 "Allowances", Part 3.3.
1. Description: Removal, disposal off-site, and replacement of unsuitable soil and/or debris with a controlled backfill material from an on-site source.
 2. Unit Price includes excavation, transportation, re-spread, compaction, and backfill to compaction requirements per specifications.
 3. This allowance includes material cost receiving, handling, and installation and Contractor overhead and profit.
 4. Quantity Allowance: Coordinate unit price with allowance adjustment requirements in Section 012100 "Allowances."
- D. Allowance No. D: Unsuitable Soil – Off-site disposal and Backfill with Off-Site Source Suitable Soils. As referenced in Section 012100 "Allowances", Part 3.3.
1. Description: Removal, disposal off-site, and replacement of unsuitable soil and/or debris with a controlled backfill material from an off-site source.

2. Unit Price includes excavation, transportation, re-spread, compaction, and backfill to compaction requirements per specifications.
 3. This allowance includes material cost receiving, handling, and installation and Contractor overhead and profit.
 4. Quantity Allowance: Coordinate unit price with allowance adjustment requirements in Section 012100 "Allowances."
- E. Allowance No. E: Unsuitable Trench Soil – On-site disposal and Backfill with On-Site Suitable Soils. As referenced in Section 012100 "Allowances", Part 3.3.
1. Description: Removal of unsuitable soil, disposal of unsuitable soil for re-use on-site, and replacement of unsuitable soil and/or debris with a controlled backfill material from an on-site source.
 2. Unit Price includes excavation, transportation, re-spread, compaction, and backfill to compaction requirements per specifications.
 3. This allowance includes material cost receiving, handling, and installation and Contractor overhead and profit.
 4. Quantity Allowance: Coordinate unit price with allowance adjustment requirements in Section 012100 "Allowances."
- F. Allowance No. F: Unsuitable Trench Soil – On-Site Disposal and Backfill with Off Site Source Suitable Soils. As referenced in Section 012100 "Allowances", Part 3.3.
1. Description: Removal of unsuitable soil, disposal for re-use on-site, and replacement of unsuitable soil and/or debris with a controlled backfill material from an off-site source.
 2. Unit Price includes excavation, transportation, re-spread, compaction, and backfill to compaction requirements per specifications.
 3. This allowance includes material cost receiving, handling, and installation and Contractor overhead and profit.
 4. Quantity Allowance: Coordinate unit price with allowance adjustment requirements in Section 012100 "Allowances."
- G. Allowance No. G: Unsuitable Trench Soil – Off-Site Disposal and Backfill With On-Site Source Suitable Soils. As referenced in Section 012100 "Allowances", Part 3.3.
1. Description: Removal unsuitable soil, disposal off-site, and replacement of unsuitable soil and/or debris with a controlled backfill material from an on-site source.
 2. Unit Price includes excavation, transportation, re-spread, compaction, and backfill to compaction requirements per specifications.
 3. This allowance includes material cost receiving, handling, and installation and Contractor overhead and profit.
 4. Quantity Allowance: Coordinate unit price with allowance adjustment requirements in Section 012100 "Allowances."
- H. Allowance No. H: Unsuitable Trench Soil – Off-Site Disposal and Backfill with Off-Site Source Suitable Soils. As referenced in Section 012100 "Allowances", Part 3.3.
1. Description: Removal, disposal off-site, and replacement of unsuitable soil and/or debris with a controlled backfill material from an off-site source.
 2. Unit Price includes excavation, transportation, re-spread, compaction, and backfill to compaction requirements per specifications.
 3. This allowance includes material cost receiving, handling, and installation and Contractor overhead and profit.

4. Quantity Allowance: Coordinate unit price with allowance adjustment requirements in Section 012100 "Allowances."

END OF SECTION 012200

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 012100 "Allowances" for products selected under an allowance.
 - 2. Section 012300 "Alternates" for products selected under an alternate.
 - 3. 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.
 - 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 to meet other Project requirements but may offer advantage to Contractor or Owner.

1.4 ACTION SUBMITTALS

- A. Substitution Requests: Submit documentation identifying 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 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, 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. General Contractor 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: Owner 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 Construction Manager 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 General Contractor.
 - 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 ADMINISTRATIVE CHANGE ORDERS

- A. Allowance Adjustment: See Section 012100 "Allowances" for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect actual costs of allowances.
- B. Unit-Price Adjustment: See Section 012200 "Unit Prices" for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect measured scope of unit-price work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012600

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 012100 "Allowances" for procedural requirements governing the handling and processing of allowances.
 - 2. Section 012200 "Unit Prices" for administrative requirements governing the use of unit prices.
 - 3. Section 012600 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
 - 4. 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 General Contractor's construction schedule.
 - 1. Coordinate line items in the schedule of values with items required to be indicated as separate activities in General Contractor's construction schedule.
 - 2. Submit the schedule of values to Architect through Construction Manager at earliest possible date, but no later than seven days before the date scheduled for submittal of initial Applications for Payment.
 - 3. Subschedules for Separate Elements of Work: Where the General Contractor's construction schedule defines separate elements of the Work, provide subschedules showing values coordinated with each element.

- 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. Owner's name.
 - c. Name of Architect.
 - d. Architect's Project number.
 - e. Contractor's name and address.
 - f. 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, Proportional Distribution: Include total cost and proportionate share of general overhead and profit for each line item.
 9. Overhead Costs, Separate Line Items: 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. Temporary Facilities: Show cost of temporary facilities and other major cost items that are not direct cost of actual work-in-place as separate line items.
11. 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.
12. 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 General Contractor and paid for by Owner.
- B. Payment Application Times: The date for each progress payment is indicated in the Owner/General Contractor Agreement. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.
 1. Submit draft copy of Application for Payment seven days prior to due date for review by General Contractor.
- C. Application for Payment Forms: Use forms provided by the General Contractor as form for Applications for Payment.
- D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. General Contractor will return incomplete applications without action.
 1. Entries shall match data on the schedule of values and General 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 three signed and notarized original copies of each Application for Payment to General Contractor by a method ensuring receipt within 24 hours. One 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. Application for Payment at Substantial Completion: After Architect issues the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
 1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
 - a. Complete administrative actions, submittals, and Work preceding this application, as described in Section 017700 "Closeout Procedures."
 2. This application shall reflect Certificate(s) of Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
- J. 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. Certification of completion of final punch list items.
 3. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
 4. Updated final statement, accounting for final changes to the Contract Sum.
 5. AIA Document G706.
 6. AIA Document G706A.
 7. AIA Document G707.
 8. Evidence that claims have been settled.
 9. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
 10. Final liquidated damages settlement statement.
 11. Proof that taxes, fees, and similar obligations are paid.
 12. Waivers and releases.

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.
 - 4. Section 018100 "Commissioning Requirements" for coordinating the Work with Owner's Commissioning Authority.

1.3 DEFINITIONS

- A. BIM: Building Information Modeling.
- B. RFI: Request for Information. Request from Owner, General Contractor, or Architect, 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, 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, in web-based Project software directory, and in prominent location in each 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. 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.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and direction of Project coordinator 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 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 subframing 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. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
 6. 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.
 7. 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, switchboard, switchgear, transformer, busway, generator, and motor-control center locations.
 - d. Location of pull boxes and junction boxes, dimensioned from column center lines.
 8. Fire-Protection System: Show the following:
 - a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.
 9. 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.
- C. Coordination Drawing Process: Prepare coordination drawings in the following manner:
1. Schedule submittal and review of Fire Sprinkler, Plumbing, HVAC, and Electrical Shop Drawings to make required changes prior to preparation of coordination drawings.
 2. Commence routing of coordination drawing files with HVAC Installer, who will provide drawing plan files denoting approved ductwork. HVAC Installer will locate ductwork and piping on a single layer, using orange color. Forward drawings to Plumbing Installer.
 3. Plumbing Installer will locate plumbing and equipment on a single layer, using blue color.
 4. Fire Sprinkler Installer will locate piping and equipment, using red color. Fire Sprinkler Installer shall forward drawing files to Electrical Installer.
 5. Electrical Installer will indicate service and feeder conduit runs and equipment in green color. Electrical Installer shall forward drawing files to Communications and Electronic Safety and Security Installer.
 6. Communications and Electronic Safety and Security Installer will indicate cable trays and cabling runs and equipment in purple color. Communications and Electronic Safety and Security Installer shall forward completed drawing files to Contractor.
 7. Contractor shall perform the final coordination review. As each coordination drawing is completed, Contractor will meet with Architect to review and resolve conflicts on the coordination drawings.
- D. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:

1. File Preparation Format:
 - a. Same digital data software program, version, and operating system as original Drawings.
2. File Submittal Format: Submit or post coordination drawing files using **PDF format**.
3. BIM File Incorporation: General Contractor will incorporate Contractor's coordination drawing files into BIM established for Project.
 - a. General Contractor will perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Architect.
4. Architect will furnish Contractor one set of digital data files of Drawings for use in preparing coordination digital data files.
 - a. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Drawings.
 - b. Digital Data Software Program: Drawings are available in **Revit (.rvt) and AutoCAD (.dwg)**.
 - c. Contractor shall execute a data licensing agreement in the form of Agreement form acceptable to Owner and Architect.

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 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. Name of Contractor/ General Contractor.
 4. Name of Architect.
 5. Date.
 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 or Software-generated form with substantially the same content as indicated above, acceptable to Architect.
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** 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 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 management software. Include the following:
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. Use of Architect's Digital Data Files: Digital data files of Architect's BIM model 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.
1. Digital Drawing Software Program: Contract Drawings are available in Revit (.rvt) or AutoCAD (.dwg).
3. Contractor shall execute a data licensing agreement in the form of AIA Document C106 Digital Data Licensing Agreement or Agreement form acceptable to Owner and Architect.
 - 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 Agreement acceptable to Owner and Architect.
4. The following digital data files will be furnished for each appropriate discipline:
 - a. Floor plans.
 - b. Reflected ceiling plans.

- B. 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 10 Project management software user licenses for use of Owner, Owner's Commissioning Authority, General Contractor, Architect, and Architect's consultants. Provide eight hours of software training at Architect's office for web-based Project software users.
 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.
- C. 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: General Contractor will schedule and conduct meetings and conferences at Project site unless otherwise indicated.
1. Attendees: 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: 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: General Contractor 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, Owner's Commissioning Authority, General Contractor, 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. Use of web-based Project software.
 - h. Procedures for processing field decisions and Change Orders.
 - i. Procedures for RFIs.
 - j. Procedures for testing and inspecting.
 - k. Procedures for processing Applications for Payment.
 - l. Distribution of the Contract Documents.
 - m. Submittal procedures.
 - n. Preparation of Record Documents.
 - o. Use of the premises.
 - p. Work restrictions.
 - q. Working hours.
 - r. Owner's occupancy requirements.
 - s. Responsibility for temporary facilities and controls.
 - t. Procedures for moisture and mold control.
 - u. Procedures for disruptions and shutdowns.
 - v. Construction waste management and recycling.
 - w. Parking availability.
 - x. Office, work, and storage areas.
 - y. Equipment deliveries and priorities.
 - z. First aid.
 - aa. Security.
 - bb. 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, General Contractor, and Owner's Commissioning Authority 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:

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- 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: General Contractor will 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 Substantial Completion.
1. Conduct the conference to review requirements and responsibilities related to Project closeout.
 2. Attendees: Authorized representatives of Owner, Owner's Commissioning Authority, General Contractor, 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 Substantial Completion 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 preparing operations and maintenance data.
 - f. Requirements for delivery of material samples, attic stock, and spare parts.
 - g. Requirements for demonstration and training.
 - h. Preparation of Contractor's punch list.
 - i. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
 - j. Submittal procedures.
 - k. Coordination of separate contracts.
 - 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: General Contractor will conduct progress meetings at regular intervals.
- 1. Coordinate dates of meetings with preparation of payment requests.
 - 2. Attendees: In addition to representatives of Owner, Owner's Commissioning Authority, General Contractor, 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) Resolution of BIM component conflicts.
 - 4) Status of submittals.
 - 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.
- F. Coordination Meetings: General Contractor will conduct coordination meetings at regular intervals. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.
 1. Attendees: In addition to representatives of Owner, Owner's Commissioning Authority, General Contractor, 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 meetings shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to combined 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.
 - b. Schedule Updating: Revise combined Contractor's construction schedule after each coordination meeting, where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
 - c. Review present and future needs of each contractor present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Resolution of BIM component conflicts.

- 4) Status of submittals.
 - 5) Deliveries.
 - 6) Off-site fabrication.
 - 7) Access.
 - 8) Site use.
 - 9) Temporary facilities and controls.
 - 10) Work hours.
 - 11) Hazards and risks.
 - 12) Progress cleaning.
 - 13) Quality and work standards.
 - 14) Status of RFIs.
 - 15) Proposal Requests.
 - 16) Change Orders.
 - 17) Pending changes.
3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from 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.
- B. Related Requirements:
 - 1. Section 014000 "Quality Requirements" for schedule of tests and inspections.
 - 2. Section 012900 "Payment Procedures" for schedule of values and requirements for use of cost-loaded schedule for Applications for Payment.

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 the critical path of Project and when activities can be performed.
- 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.
 - 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, cost and 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.
- B. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to the preliminary construction schedule and Contractor's Construction Schedule, including, but not limited to, the following:
 - 1. Review software limitations and content and format for reports.
 - 2. Verify availability of qualified personnel needed to develop and update schedule.
 - 3. Discuss constraints, including phasing, work stages, area separations and interim milestones.
 - 4. Review delivery dates for Owner-furnished products.
 - 5. Review schedule for work of Owner's separate contracts.
 - 6. Review submittal requirements and procedures.
 - 7. Review time required for review of submittals and resubmittals.
 - 8. Review requirements for tests and inspections by independent testing and inspecting agencies.
 - 9. Review time required for Project closeout and Owner startup procedures, including commissioning activities.
 - 10. Review and finalize list of construction activities to be included in schedule.
 - 11. Review procedures for updating schedule.

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

- 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. Activities: Treat each floor or separate area as a separate numbered activity for each main element of the Work. Comply with the following:
 - 1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.
 - 2. Temporary Facilities: Indicate start and completion dates for the following as applicable:
 - a. Securing of approvals and permits required for performance of the Work.
 - b. Temporary facilities.
 - c. Construction of mock-ups, prototypes and samples.
 - d. Owner interfaces and furnishing of items.
 - e. Interfaces with Separate Contracts.
 - f. Regulatory agency approvals.
 - g. Punch list.
 - 3. Procurement Activities: Include procurement process activities for the following long lead-time items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
 - a. TBD.
 - 4. Submittal Review Time: Include review and resubmittal times indicated in Section 013300 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with submittal schedule.
 - 5. Startup and Testing Time: Include no fewer than 15 days for startup and testing.
 - 6. Commissioning Time: Include no fewer than 15 days for commissioning.
 - 7. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's and General Contractor's administrative procedures necessary for certification of Substantial Completion.
 - 8. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and Final Completion.
- D. 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. Phasing: Arrange list of activities on schedule by phase.
 - 2. Work under More Than One Contract: Include a separate activity for each contract.

3. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
 4. 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.
 5. 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.
 6. 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.
 7. 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. Building flush-out.~~
 - m. Startup and placement into final use and operation.
 - n. Commissioning.
 8. 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.
- E. 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.
- F. 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.
- G. 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.
- H. Distribution: Distribute copies of approved schedule to Architect, General Contractor, Owner, separate contractors, testing and inspecting agencies, and other parties identified by General 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. CPM Schedule: Submit startup, horizontal, CPM 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 REQUIREMENTS
- A. 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 General 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. Commissioning.
 - k. Punch list and Final Completion.
 - l. 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.

1.10 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 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 012900 "Payment Procedures" for submitting Applications for Payment and the schedule of values.
 - 2. Section 013100 "Project Management and Coordination" for submitting coordination drawings and subcontract list and for requirements for web-based Project software.
 - 3. Section 013200 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
 - 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.
 - 8. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.

1.3 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Architect's and General 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 General 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 General 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 Schedule: 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 Schedule: Submit concurrently with the first complete submittal of Contractor's construction schedule.
 - a. Submit revised submittal schedule as required 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 General 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. 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.

- B. Options: Identify options requiring selection by Architect.
- C. 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 General Contractor on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.
- D. Submittals Utilizing Web-Based Project Software: Prepare submittals as PDF files or other format indicated by Project management software.

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 Management Software: Prepare submittals in PDF form, and upload to web-based Project management 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 and General Contractor 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 Architect before being returned to Contractor.
 - a. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Architect and General Contractor.

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 and General Contractor'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 and General Contractor'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.

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- 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 concurrently 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.
 2. BIM Incorporation: General Contractor will incorporate Contractor's Shop Drawing files into BIM established for Project.
- C. Samples: Submit Samples for review of type, 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 Management 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, through General Contractor, 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 and General Contractor 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 AWS B2.1/B2.1M 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 substrate preparation and primers required.
 - 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 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.
- C. BIM Incorporation: General Contractor will incorporate delegated-design drawing and data files into BIM established for Project.
 1. Prepare delegated-design drawings in the following format: Same digital data software program, version, and operating system as original Drawings.

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 and General Contractor.
- B. Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp indication in web-based Project management 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 and General Contractor will not review submittals received from Contractor that do not have Contractor's review and approval.

1.10 ARCHITECT'S AND GENERAL CONTRACTOR'S REVIEW

- A. Action Submittals: Architect and General Contractor will review each submittal, indicate corrections or revisions required, and return.
 1. PDF Submittals: Architect and General Contractor will indicate, via markup on each submittal, the appropriate action.
 2. Paper Submittals: Architect and General Contractor will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.
 3. Submittals by Web-Based Project Management Software: Architect and General Contractor will indicate, on Project management software website, the appropriate action.
- B. Informational Submittals: Architect and General Contractor will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect and General Contractor 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 and General Contractor.
- D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- E. Architect and General Contractor will return without review 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

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, Commissioning Authority, Design-Builder, or authorities having jurisdiction are not limited by provisions of this Section.
 - 4. Specific test and inspection requirements are not specified in this Section.
- C. Related Requirements:
 - 1. Section 012100 "Allowances" for testing and inspection allowances.

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 and Inspections: 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 Work result does not require that certain construction activities specified apply exclusively to specific trade(s).
- D. Mockups: Full-size physical assemblies of portions of the Work constructed to establish the standard by which the Work will be judged. Mockups are not Samples.
1. Mockups are used for one or more of the following:
 - a. Verify selections made under Sample submittals.
 - b. Demonstrate aesthetic effects.
 - c. Demonstrate the qualities of products and workmanship.
 - d. Demonstrate successful installation of interfaces between components and systems.
 - e. Perform preconstruction testing to determine system performance.
 2. Product Mockups: Mockups that may include multiple products, materials, or systems specified in a single Section.
 3. In-Place Mockups: Mockups constructed on-site in their actual final location as part of permanent construction.
- 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. Unless otherwise indicated, copies of reports of tests or inspections performed for other than the Project do not meet this definition.
- 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 and Inspections: Tests and inspections that are performed at the source (e.g., plant, mill, factory, or shop).
- H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. The term "testing laboratory" has the same meaning as the term "testing agency."
- I. 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.
- J. 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 or Design-Builder.

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.
- B. Delegated Design Services Statement: 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.

1.5 CONFLICTING REQUIREMENTS

- A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements is specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, inform the Architect regarding the conflict and obtain clarification prior to proceeding with the Work. Refer conflicting requirements that are different, but apparently equal, to Architect for clarification before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified is 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. Mockup Shop Drawings:
 - 1. Include plans, sections, elevations, and details, indicating materials and size of mockup construction.
 - 2. Indicate manufacturer and model number of individual components.
 - 3. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.
- B. 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. Primary wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.
- D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- E. 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.
- F. Reports: Prepare and submit certified written reports and documents as specified.
- G. 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 and to coordinate Owner's quality-assurance and quality-control activities. 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.
 - 3. Owner-performed tests and inspections indicated in the Contract Documents, including tests and inspections indicated to be performed by Commissioning Authority.
- 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 the 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 reinspecting.

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 of 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 of whether conditions, products, and installation will affect warranty.
5. Other required items indicated in individual Specification Sections.

1.10 QUALITY ASSURANCE

- A. 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 is similar in material, design, and extent to those indicated for this Project.
- F. Specialists: Certain Specification Sections require that specific construction activities be performed by entities who are recognized experts in those operations. Specialists will satisfy qualification requirements indicated and engage in the activities indicated.
 - 1. Requirements of authorities having jurisdiction supersede requirements for specialists.
- G. Testing and Inspecting Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented in accordance with ASTM E329, and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
- H. 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.
- I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect, demonstrate, repair, and perform service on installations of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- J. 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 Contractor's responsibilities, including the following:
 - 1. Provide test specimens representative of proposed products and construction.
 - 2. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
 - 3. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
 - 4. Build site-assembled test assemblies and mockups, using installers who will perform same tasks for Project.
 - 5. When testing is complete, remove test specimens and test assemblies, and mockups; do not reuse products on Project.
 - 6. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect and Commissioning Authority, through Design-Builder, with copy to Contractor. Interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from the Contract Documents.

- K. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed 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. Notify Architect and Design-Builder seven days in advance of dates and times when mockups will be constructed.
 4. Employ supervisory personnel who will oversee mockup construction. Employ workers who will be employed to perform same tasks during the construction at Project.
 5. Demonstrate the proposed range of aesthetic effects and workmanship.
 6. Obtain Architect's and Design-Builder's approval of mockups before starting corresponding Work, fabrication, or construction.
 - a. Allow seven days for initial review and each re-review of each mockup.
 7. Promptly correct unsatisfactory conditions noted by Architect's preliminary review, to the satisfaction of the Architect, before completion of final mockup.
 8. Approval of mockups by the Architect does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 9. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 10. Demolish and remove mockups when directed unless otherwise indicated.

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 specified in Section 012100 "Allowances," as authorized by Change Orders.
 3. Costs for retesting and reinspecting construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to Contractor.
- 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 will 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/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- D. Testing Agency Responsibilities: Cooperate with Architect, Commissioning Authority, Design-Builder, and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Architect, Commissioning Authority, Design-Builder, 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. Contractor's Associated Requirements and 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 and submit with each Application for Payment.
1. Schedule Contents: Include tests, inspections, and quality-control services, including Contractor- and Owner-retained services, commissioning activities, and other Project-required services paid for by other entities.
 2. Distribution: Distribute schedule to Owner, Architect, Commissioning Authority, Design-Builder, 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, Commissioning Authority, Design-Builder, 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 Commissioning Authority, through Design-Builder, with copy to Contractor and to authorities having jurisdiction.
 4. Submitting a final report of special tests and inspections at Substantial Completion, 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 reinspecting corrected Work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

- A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
 - 1. Date test or inspection was conducted.
 - 2. Description of the Work tested or inspected.
 - 3. Date test or inspection results were transmitted to Architect.
 - 4. Identification of testing agency or special inspector conducting test or inspection.
- B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's, Commissioning Authority's, and Design-Builder's and authorities' having jurisdiction reference during normal working hours.
 - 1. Submit log at Project closeout as part of Project Record Documents.

3.2 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 014200 - REFERENCES

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 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.

1.3 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.
 - 1. For standards referenced by applicable building codes, comply with dates of standards as listed in building codes.
- 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.

1.4 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 in the following list. Abbreviations and acronyms not included in this list 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." The information in this list 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 Sanitary Engineering; www.asse-plumbing.org.
34. ASSP - American Society of Safety Professionals (The); www.assp.org.
35. ASTM - ASTM International; www.astm.org.
36. ATIS - Alliance for Telecommunications Industry Solutions; www.atis.org.
37. AVIXA - Audiovisual and Integrated Experience Association; (Formerly: Infocomm International); www.soundandcommunications.com.
38. AWEA - American Wind Energy Association; www.awea.org.
39. AWI - Architectural Woodwork Institute; www.awinet.org.
40. AWMAC - Architectural Woodwork Manufacturers Association of Canada; www.awmac.com.
41. AWPA - American Wood Protection Association; www.awpa.com.
42. AWS - American Welding Society; www.aws.org.
43. AWWA - American Water Works Association; www.awwa.org.
44. BHMA - Builders Hardware Manufacturers Association; www.buildershardware.com.
45. BIA - Brick Industry Association (The); www.gobrick.com.
46. BICSI - BICSI, Inc.; www.bicsi.org.
47. CDA - Copper Development Association; www.copper.org.
48. CFFA - Chemical Fabrics and Film Association, Inc.; www.chemicalfabricsandfilm.com.
49. CFSEI - Cold-Formed Steel Engineers Institute; www.cfsei.org.
50. CGA - Compressed Gas Association; www.cganet.com.
51. CIMA - Cellulose Insulation Manufacturers Association; www.cellulose.org.
52. CISCA - Ceilings & Interior Systems Construction Association; www.cisca.org.
53. CISPI - Cast Iron Soil Pipe Institute; www.cispi.org.
54. CLFMI - Chain Link Fence Manufacturers Institute; www.chainlinkinfo.org.
55. CPA - Composite Panel Association; www.compositepanel.org.
56. CRI - Carpet and Rug Institute (The); www.carpet-rug.org.
57. CRRC - Cool Roof Rating Council; www.coolroofs.org.
58. CRSI - Concrete Reinforcing Steel Institute; www.crsi.org.
59. CSA - CSA Group; www.csa-group.org.
60. CSI - Construction Specifications Institute (The); www.csiresources.org.
61. CSSB - Cedar Shake & Shingle Bureau; www.cedarbureau.org.
62. CTA - Consumer Technology Association; www.cta.tech.
63. CTI - Cooling Technology Institute; (Formerly: Cooling Tower Institute); www.coolingtechnology.org.
64. CWC - Composite Wood Council; (See CPA).
65. DASMA - Door and Access Systems Manufacturers Association; www.dasma.com.
66. DHA - Decorative Hardwoods Association; (Formerly: Hardwood Plywood & Veneer Association); www.decorativehardwoods.org.
67. DHI - Door and Hardware Institute; www.dhi.org.
68. ECA - Electronic Components Association; (See ECIA).

69. ECAMA - Electronic Components Assemblies & Materials Association; (See ECIA).
70. ECIA - Electronic Components Industry Association; www.ecianow.org.
71. EIA - Electronic Industries Alliance; (See TIA).
72. EJMA - Expansion Joint Manufacturers Association, Inc.; www.ejma.org.
73. EOS/ESD Association; (Electrostatic Discharge Association); www.esda.org.
74. ESTA - Entertainment Services and Technology Association; (See PLASA).
75. ETL - Intertek (See Intertek); www.intertek.com.
76. EVO - Efficiency Valuation Organization; www.evo-world.org.
77. FCI - Fluid Controls Institute; www.fluidcontrolsintstitute.org.
78. FIBA - Federation Internationale de Basketball; (The International Basketball Federation); www.fiba.com.
79. FIVB - Federation Internationale de Volleyball; (The International Volleyball Federation); www.fivb.org.
80. FM Approvals - FM Approvals LLC; www.fmglobal.com.
81. FM Global - FM Global; (Formerly: FMG - FM Global); www.fmglobal.com.
82. FRSA - Florida Roofing, Sheet Metal Contractors Association, Inc.; www.floridarooft.com.
83. FSA - Fluid Sealing Association; www.fluidsealing.com.
84. FSC - Forest Stewardship Council U.S.; www.fscus.org.
85. GA - Gypsum Association; www.gypsum.org.
86. GANA - Glass Association of North America; (See NGA).
87. GS - Green Seal; www.greenseal.org.
88. HI - Hydraulic Institute; www.pumps.org.
89. HI/GAMA - Hydronics Institute/Gas Appliance Manufacturers Association; (See AHRI).
90. HMMA - Hollow Metal Manufacturers Association; (See NAAMM).
91. HPVA - Hardwood Plywood & Veneer Association; (See DHA).
92. HPW - H. P. White Laboratory, Inc.; www.hpwhite.com.
93. IAPSC - International Association of Professional Security Consultants; www.iapsc.org.
94. IAS - International Accreditation Service; www.iasonline.org.
95. ICBO - International Conference of Building Officials; (See ICC).
96. ICC - International Code Council; www.iccsafe.org.
97. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
98. ICPA - International Cast Polymer Association; www.theicpa.com.
99. ICRI - International Concrete Repair Institute, Inc.; www.icri.org.
100. IEC - International Electrotechnical Commission; www.iec.ch.
101. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
102. IES - Illuminating Engineering Society; (Formerly: Illuminating Engineering Society of North America); www.ies.org.
103. IESNA - Illuminating Engineering Society of North America; (See IES).
104. IEST - Institute of Environmental Sciences and Technology; www.iest.org.
105. IGMA - Insulating Glass Manufacturers Alliance; www.igmaonline.org.
106. IGSHPA - International Ground Source Heat Pump Association; www.igshpa.org.
107. II - Infocomm International; (See AVIXA).
108. ILI - Indiana Limestone Institute of America, Inc.; www.iliai.com.
109. Intertek - Intertek Group; (Formerly: ETL SEMCO; Intertek Testing Service NA); www.intertek.com.
110. ISA - International Society of Automation (The); (Formerly: Instrumentation, Systems, and Automation Society); www.isa.org.
111. ISAS - Instrumentation, Systems, and Automation Society (The); (See ISA).

112. ISFA - International Surface Fabricators Association; (Formerly: International Solid Surface Fabricators Association); www.isfanow.org.
113. ISO - International Organization for Standardization; www.iso.org.
114. ISSFA - International Solid Surface Fabricators Association; (See ISFA).
115. ITU - International Telecommunication Union; www.itu.int.
116. KCMA - Kitchen Cabinet Manufacturers Association; www.kcma.org.
117. LMA - Laminating Materials Association; (See CPA).
118. LPI - Lightning Protection Institute; www.lightning.org.
119. MBMA - Metal Building Manufacturers Association; www.mbma.com.
120. MCA - Metal Construction Association; www.metalconstruction.org.
121. MFMA - Maple Flooring Manufacturers Association, Inc.; www.maplefloor.org.
122. MFMA - Metal Framing Manufacturers Association, Inc.; www.metalframingmfg.org.
123. MHI - Material Handling Industry of America; www.mhia.org.
124. MIA - Marble Institute of America; (See NSI).
125. MMPA - Moulding & Millwork Producers Association; www.wmmpa.com.
126. MPI - Master Painters Institute; www.paintinfo.com.
127. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry Inc.; www.mss-hq.org.
128. NAAMM - National Association of Architectural Metal Manufacturers; www.naamm.org.
129. NACE - NACE International; (National Association of Corrosion Engineers International); www.nace.org.
130. NADCA - National Air Duct Cleaners Association; www.nadca.com.
131. NAIMA - North American Insulation Manufacturers Association; www.naima.org.
132. NALP - National Association of Landscape Professionals; www.landscapeprofessionals.org.
133. NBGQA - National Building Granite Quarries Association, Inc.; www.nbgqa.com.
134. NBI - New Buildings Institute; www.newbuildings.org.
135. NCAA - National Collegiate Athletic Association (The); www.ncaa.org.
136. NCMA - National Concrete Masonry Association; www.ncma.org.
137. NEBB - National Environmental Balancing Bureau; www.nebb.org.
138. NECA - National Electrical Contractors Association; www.necanet.org.
139. NeLMA - Northeastern Lumber Manufacturers Association; www.nelma.org.
140. NEMA - National Electrical Manufacturers Association; www.nema.org.
141. NETA - InterNational Electrical Testing Association; www.netaworld.org.
142. NFHS - National Federation of State High School Associations; www.nfhs.org.
143. NFPA - National Fire Protection Association; www.nfpa.org.
144. NFPA - NFPA International; (See NFPA).
145. NFRC - National Fenestration Rating Council; www.nfrc.org.
146. NGA - National Glass Association (The); (Formerly: Glass Association of North America); www.glass.org.
147. NHLA - National Hardwood Lumber Association; www.nhla.com.
148. NLGA - National Lumber Grades Authority; www.nlga.org.
149. NOFMA - National Oak Flooring Manufacturers Association; (See NWFA).
150. NOMMA - National Ornamental & Miscellaneous Metals Association; www.nomma.org.
151. NRCA - National Roofing Contractors Association; www.nrca.net.
152. NRMCA - National Ready Mixed Concrete Association; www.nrmca.org.
153. NSF - NSF International; www.nsf.org.
154. NSI - National Stone Institute; (Formerly: Marble Institute of America); www.naturalstoneinstitute.org.

155. NSPE - National Society of Professional Engineers; www.nspe.org.
156. NSSGA - National Stone, Sand & Gravel Association; www.nssga.org.
157. NTMA - National Terrazzo & Mosaic Association, Inc. (The); www.ntma.com.
158. NWRA - National Waste & Recycling Association; www.wasterecycling.org
159. PCI - Precast/Prestressed Concrete Institute; www.pci.org.
160. PDI - Plumbing & Drainage Institute; www.pdionline.org.
161. PLASA - PLASA; (Formerly: ESTA - Entertainment Services and Technology Association); www.plasa.org.
162. RCSC - Research Council on Structural Connections; www.boltcouncil.org.
163. RFCI - Resilient Floor Covering Institute; www.rfci.com.
164. RIS - Redwood Inspection Service; www.redwoodinspection.com.
165. SAE - SAE International; www.sae.org.
166. SCTE - Society of Cable Telecommunications Engineers; www.scte.org.
167. SDI - Steel Deck Institute; www.sdi.org.
168. SDI - Steel Door Institute; www.steeldoor.org.
169. SEFA - Scientific Equipment and Furniture Association (The); www.sefalabs.com.
170. SEI/ASCE - Structural Engineering Institute/American Society of Civil Engineers; (See ASCE).
171. SIA - Security Industry Association; www.siaonline.org.
172. SJI - Steel Joist Institute; www.steeljoist.org.
173. SMA - Screen Manufacturers Association; www.smainfo.org.
174. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
175. SPFA - Spray Polyurethane Foam Alliance; www.sprayfoam.org.
176. SPIB - Southern Pine Inspection Bureau; www.spib.org.
177. SPRI - Single Ply Roofing Industry; www.spri.org.
178. SRCC - Solar Rating & Certification Corporation; www.solar-rating.org.
179. SSINA - Specialty Steel Industry of North America; www.ssina.com.
180. SSPC - SSPC: The Society for Protective Coatings; www.sspc.org.
181. STI - Steel Tank Institute; www.steeltank.com.
182. SWI - Steel Window Institute; www.steelwindows.com.
183. SWPA - Submersible Wastewater Pump Association; www.swpa.org.
184. TCNA - Tile Council of North America, Inc.; www.tileusa.com.
185. TEMA - Tubular Exchanger Manufacturers Association, Inc.; www.tema.org.
186. TIA - Telecommunications Industry Association (The); (Formerly: TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance); www.tiaonline.org.
187. TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance; (See TIA).
188. TMS - The Masonry Society; www.masonrysociety.org.
189. TPI - Truss Plate Institute; www.tpinst.org.
190. TPI - Turfgrass Producers International; www.turfgrasssod.org.
191. TRI - Tile Roofing Institute; www.tilerroofing.org.
192. UL - Underwriters Laboratories Inc.; www.ul.com.
193. UNI - Uni-Bell PVC Pipe Association; www.uni-bell.org.
194. USAV - USA Volleyball; www.usavolleyball.org.
195. USGBC - U.S. Green Building Council; www.usgbc.org.
196. WA - Wallcoverings Association; www.wallcoverings.org.
197. WCLIB - West Coast Lumber Inspection Bureau; www.wclib.org.
198. WCMA - Window Covering Manufacturers Association; www.wcmanet.org.

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199. WDMA - Window & Door Manufacturers Association; www.wdma.com.
 200. WI - Woodwork Institute; www.wicnet.org.
- B. 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. IAPMO - International Association of Plumbing and Mechanical Officials; www.iapmo.org.
 2. ICC - International Code Council; www.iccsafe.org.
 3. ICC-ES - ICC Evaluation Service, LLC; www.icc-es.org.
- C. Federal Government 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. Information is subject to change and is up to date as of the date of the Contract Documents.
1. COE - Army Corps of Engineers; www.usace.army.mil.
 2. CPSC - Consumer Product Safety Commission; www.cpsc.gov.
 3. DOC - Department of Commerce; National Institute of Standards and Technology; www.nist.gov.
 4. DOD - Department of Defense; www.quicksearch.dla.mil.
 5. DOE - Department of Energy; www.energy.gov.
 6. EPA - Environmental Protection Agency; www.epa.gov.
 7. FAA - Federal Aviation Administration; www.faa.gov.
 8. FG - Federal Government Publications; www.gpo.gov/fdsys.
 9. GSA - General Services Administration; www.gsa.gov.
 10. HUD - Department of Housing and Urban Development; www.hud.gov.
 11. LBL - Lawrence Berkeley National Laboratory; Environmental Energy Technologies Division; www.eetd.lbl.gov.
 12. OSHA - Occupational Safety & Health Administration; www.osha.gov.
 13. SD - Department of State; www.state.gov.
 14. TRB - Transportation Research Board; National Cooperative Highway Research Program; The National Academies; www.trb.org.
 15. USDA - Department of Agriculture; Agriculture Research Service; U.S. Salinity Laboratory; www.ars.usda.gov.
 16. USDA - Department of Agriculture; Rural Utilities Service; www.usda.gov.
 17. USDOJ - Department of Justice; Office of Justice Programs; National Institute of Justice; www.ojp.usdoj.gov.
 18. USP - U.S. Pharmacopeial Convention; www.usp.org.
 19. USPS - United States Postal Service; www.usps.com.
- D. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations 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. CFR - Code of Federal Regulations; Available from Government Printing Office; www.govinfo.gov.
 2. DOD - Department of Defense; Military Specifications and Standards; Available from DLA Document Services; www.quicksearch.dla.mil.

3. DSCC - Defense Supply Center Columbus; (See FS).
 4. FED-STD - Federal Standard; (See FS).
 5. FS - Federal Specification; Available from DLA Document Services;
www.quicksearch.dla.mil.
 - a. Available from Defense Standardization Program; www.dsp.dla.mil.
 - b. Available from General Services Administration; www.gsa.gov.
 - c. Available from National Institute of Building Sciences/Whole Building Design Guide; www.wbdg.org.
 6. MILSPEC - Military Specification and Standards; (See DOD).
 7. USAB - United States Access Board; www.access-board.gov.
 8. USATBCB - U.S. Architectural & Transportation Barriers Compliance Board; (See USAB).
- E. State Government 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 subject to change and is believed to be accurate as of the date of the Contract Documents.
1. CBHF; State of California; Department of Consumer Affairs; Bureau of Electronic and Appliance Repair, Home Furnishings and Thermal Insulation; www.bearhfti.ca.gov.
 2. CCR; California Code of Regulations; Office of Administrative Law; California Title 24 Energy Code; www.calregs.com.
 3. CDHS; California Department of Health Services; (See CDPH).
 4. CDPH; California Department of Public Health; Indoor Air Quality Program; www.cdph.ca.gov/Programs/CCDCPHP/DEODC/EHLB/IAQ/Pages/Main-Page.aspx.
 5. CPUC; California Public Utilities Commission; www.cpuc.ca.gov.
 6. SCAQMD; South Coast Air Quality Management District; www.aqmd.gov.
 7. TFS; Texas A&M Forest Service; Sustainable Forestry and Economic Development; www.txforestsERVICE.tamu.edu.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 014200

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

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 requirements for temporary utilities, support facilities, and security and protection facilities.
- B. Related Requirements:
 - 1. Section 011000 "Summary" for work restrictions and limitations on utility interruptions.
 - 2. Section 012100 "Allowances" for allowance for metered use of temporary utilities.

1.3 USE CHARGES

- A. Installation, removal, and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, Architect, occupants of Project, testing agencies, and authorities having jurisdiction.
- B. Sewer Service: Pay sewer-service use charges for sewer usage by all entities for construction operations.
- C. Water Service: Pay water-service use charges for water used by all entities for construction operations.
- D. Electric Power Service: Pay electric-power-service use charges for electricity used by all entities for construction operations.

1.4 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 the Owner. Include the following:
 - 1. Methods used to meet the goals and requirements of the 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 the Owner.

1.5 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 the United States Access Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

1.6 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. Chain-Link Fencing: Minimum 2-inch (50-mm), 0.148-inch- (3.8-mm-) thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet (1.8 m) high with galvanized-steel pipe posts; minimum 2-3/8-inch- (60-mm-) OD line posts and 2-7/8-inch- (73-mm-) OD corner and pull posts, with 1-5/8-inch- (42-mm-) OD top rails.
- B. Fencing Windscreen Privacy Screen: Polyester fabric scrim with grommets for attachment to chain-link fence, sized to height of fence, in color selected by Architect from manufacturer's standard colors.
- C. Dust-Control Adhesive-Surface Walk-Off Mats: Provide mats, minimum 36 by 60 inches (914 by 1524 mm).
- D. 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 TEMPORARY FACILITIES

- A. Field Offices: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
- B. Common-Use Field Office: Of sufficient size to accommodate needs of Owner, Architect, Design-Builder, and construction personnel office activities and to accommodate Project meetings specified in other Division 01 Sections. Keep office clean and orderly. Furnish and equip offices as follows:
 - 1. Furniture required for Project-site documents, including file cabinets, plan tables, plan racks, and bookcases.
 - 2. Conference room of sufficient size to accommodate meetings of 10 individuals. Provide electrical power service and 120-V ac duplex receptacles, with no fewer than one

- receptacle on each wall. Furnish room with conference table, chairs, and 4-foot- (1.2-m-) square tack and marker boards.
 - 3. Drinking water and private toilet.
 - 4. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F (20 to 22 deg C).
 - 5. Lighting fixtures capable of maintaining average illumination of 20 fc (215 lx) at desk height.
- C. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
- 1. Store combustible materials apart from building.

2.3 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.

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.
 - 1. Connect temporary sewers to municipal system or private system indicated as directed by authorities having jurisdiction.
- C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.
- 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.
- 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: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
 - 1. Install electric power service underground unless otherwise indicated.
- 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.

- H. Electronic Communication Service: Provide secure WiFi wireless connection to internet with provisions for access by Architect and Owner.

3.4 SUPPORT FACILITIES INSTALLATION

- A. Comply with the following:
 - 1. Provide construction for temporary field offices, shops, and sheds located within construction area or within 30 feet (9 m) of building lines that is noncombustible in accordance with ASTM E136. Comply with NFPA 241.
 - 2. Maintain support facilities until Architect schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.
- B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas as indicated on Drawings.
 - 1. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.
- C. 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 Substantial Completion. Repair hot-mix asphalt base-course pavement before installation of final course in accordance with Section 321216 "Asphalt Paving."
- D. 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.
- E. Parking: Provide temporary parking areas for construction personnel.
- F. Storage and Staging: Use designated areas of Project site for storage and staging needs.
- G. 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.
- H. 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.
- I. Waste Disposal Facilities: Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."
- J. 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.
- K. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.
- L. 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 Substantial Completion.

3.5 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. 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."
- B. Temporary Erosion and Sedimentation Control: Comply with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent and requirements specified in Section 311000 "Site Clearing."
- C. 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.
- D. Tree and Plant Protection: Comply with requirements specified in Section 015639 "Temporary Tree and Plant Protection."
- E. 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 Substantial Completion. Perform control operations lawfully, using materials approved by authorities having jurisdiction.

- F. Site Enclosure Fence: Prior to commencing earthwork, furnish and install site enclosure fence in a manner that will prevent people from easily entering site except by entrance gates.
 - 1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.
- G. 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 entrances at end of each workday.
- H. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- I. 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.
- J. 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.
- K. 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 Substantial Completion.
- 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 Substantial Completion. 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 Substantial Completion, 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 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. Salvaged items or items reused from other projects are not considered new products. Items that are manufactured or fabricated to include recycled content materials are considered new products, unless indicated otherwise.
 - 3. Comparable Product: Product by named manufacturer that is demonstrated and approved through the comparable product submittal process described in Part 2 "Comparable Products" Article, 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. Published attributes and characteristics of basis-of-design product establish salient characteristics of products.
 - 1. Evaluation of Comparable Products: 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. Manufacturer's published attributes and characteristics of basis-of-design product also establish salient characteristics of products for purposes of evaluating comparable products.

- 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 or substitution request, if applicable.
- D. Comparable Product Request Submittal: An action submittal requesting consideration of a comparable product, including the following information:
 - 1. Identification of basis-of-design product or fabrication or installation method to be replaced, including Specification Section number and title and Drawing numbers and titles.
 - 2. Data indicating compliance with the requirements specified in Part 2 "Comparable Products" Article.
- E. Basis-of-Design Product Specification Submittal: An action submittal complying with requirements in Section 013300 "Submittal Procedures."
- F. Substitution: Refer to Section 012500 "Substitution Procedures" for definition and limitations on substitutions.

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.
 - 1. 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. Resolution of Compatibility Disputes between Multiple Contractors:
 - a. Contractors are responsible for providing products and construction methods compatible with products and construction methods of other contractors.
 - b. If a dispute arises between the multiple 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- 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 equipment identification requirements.

1.5 COORDINATION

- A. Modify or adjust affected work as necessary to integrate work of approved comparable products and approved substitutions.

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 that products are undamaged and properly protected.

C. Storage:

1. Provide a secure location and enclosure at Project site for storage of materials and equipment.
2. Store products to allow for inspection and measurement of quantity or counting of units.
3. Store materials in a manner that will not endanger Project structure.
4. Store products that are subject to damage by the elements under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation and with adequate protection from wind.
5. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
7. Protect stored products from damage and liquids from freezing.

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 standard warranty form furnished by individual manufacturer for a particular product and issued in the name of the Owner or endorsed by manufacturer to Owner.
 2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner and issued in the name of the Owner or endorsed by manufacturer to 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 in the Project Manual, 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 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 through General Contractor in order to establish equivalency of proposed products. Unless otherwise indicated, 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 that 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 that 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."
 - b. Provision of products of an unnamed manufacturer is not considered a substitution, if the product complies with requirements.
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 may additionally 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 the following 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.
 2. Detailed comparison of significant qualities of proposed product with those of the named basis-of-design product. 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.
 3. Evidence that proposed product provides specified warranty.
 4. List of similar installations for completed projects, with project names and addresses and names and addresses of architects and owners, if requested.
 5. Samples, if requested.
- B. Submittal Requirements, Two-Step Process: 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 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.
 - 9. Correction of the Work.
- B. Related Requirements:
 - 1. Section 011000 "Summary" for coordination of Owner-furnished products and limits on use of Project site.
 - 2. Section 013300 "Submittal Procedures" for submitting surveys.

1.2 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.

1.3 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. Inform Architect and Construction Manager of scheduled meeting. 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 affected by cutting and patching operations.
2. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.4 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.
- C. Cutting and Patching Plan: Submit plan describing procedures at least **10** days prior to the time cutting and patching will be performed. Include the following information:
 1. Extent: Describe reason for and extent of each occurrence of cutting and patching.
 2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.
 3. Products: List products to be used for patching and firms or entities that will perform patching work.
 4. Dates: Indicate when cutting and patching will be performed.

1.5 QUALITY ASSURANCE

- A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.
- B. Professional Engineer Qualifications: Refer to Section 014000 "Quality Requirements."
- C. 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, or when encountering the need for cutting and patching of elements whose structural function is not known, 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. Fire-suppression systems.
 - e. Plumbing piping systems.
 - f. Mechanical systems piping and ducts.
 - g. Control systems.
 - h. Communication systems.
 - i. Fire-detection and -alarm systems.
 - j. Conveying systems.
 - k. Electrical wiring systems.
 - l. 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.
- D. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of specified products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Comply with requirements specified in other Sections.
- 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. Use materials that are not considered hazardous.
- C. 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.

1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities and other construction affecting the Work.
 1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, gas service piping, and water-service piping; underground electrical services; and other utilities.
 2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- B. 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.
- C. 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, including Specification Section number and paragraph, and Drawing sheet number and detail, where applicable.
 2. List of detrimental conditions, including substrates.
 3. List of unacceptable installation tolerances.
 4. Recommended corrections.
- D. 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, submit a request for information to Architect through Construction Manager in accordance with 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 and existing conditions. If discrepancies are discovered, notify Architect and Construction Manager promptly.
- B. Engage a land surveyor experienced in laying out the Work, using the following accepted surveying practices:
 - 1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
 - 2. Establish limits on use of Project site.
 - 3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
 - 4. Inform installers of lines and levels to which they must comply.
 - 5. Check the location, level and plumb, of every major element as the Work progresses.
 - 6. Notify Architect and Construction Manager when deviations from required lines and levels exceed allowable tolerances.
 - 7. 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 and Construction Manager.

3.4 FIELD ENGINEERING

- A. Identification: Owner will identify existing benchmarks, control points, and property corners.
- B. 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 or Construction Manager. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect and Construction Manager before proceeding.
 - 2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- C. 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.
- D. Final Property Survey: Engage a land surveyor to prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by land surveyor, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.
 - 1. Show boundary lines, monuments, streets, site improvements and utilities, existing improvements and significant vegetation, adjoining properties, acreage, grade contours, and the distance and bearing from a site corner to a legal point.

3.5 INSTALLATION

- A. 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 (2440 mm)** in occupied spaces and **90 inches (2300 mm)** in unoccupied spaces, unless otherwise indicated on Drawings.

- 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 satisfactory results as judged by Architect. Maintain conditions required for product performance until Substantial Completion.
- 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 of type expected for Project.
- 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: 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 with manufacturer.
 - 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, as judged by Architect. Fit exposed connections together to form hairline joints.
- J. Repair or remove and replace damaged, defective, or nonconforming Work.
- K. Comply with Section 017700 "Closeout Procedures" for repairing or removing and replacing defective Work.

3.6 CUTTING AND PATCHING

- A. 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. 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.
- F. 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, as judged by Architect. 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 eliminate 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, corner to corner of wall and edge to edge of ceiling. 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.
- G. 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 COORDINATION OF OWNER'S PORTION OF THE WORK

- A. Site Access: Provide access to Project site for Owner's construction personnel.
 1. Provide temporary facilities required for Owner-furnished, Contractor-installed products.
 2. Refer to Section 011000 "Summary" for other requirements for Owner-furnished, Contractor-installed products.
- 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. 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 (27 deg C).
 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.
- 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: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- 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 Substantial Completion.
- 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. Coordinate startup and adjusting of equipment and operating components with requirements in Section 019113 "General Commissioning Requirements."
- B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- C. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- E. 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 Substantial Completion.
- 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.

3.11 CORRECTION OF THE WORK

- A. Repair or remove and replace damaged, defective, or nonconforming Work. Restore damaged substrates and finishes.
 - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- B. Repair Work previously completed and subsequently damaged during construction period. Repair to like-new condition.
- C. Restore permanent facilities used during construction to their specified condition.
- D. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- E. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
- F. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

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.
 - 2. Section 311000 "Site Clearing" for disposition of waste resulting from site clearing and removal of above- and below-grade improvements.

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. Demolition Waste: Building, structure, and site improvement materials resulting from demolition operations.
- C. 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.
- D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.
- E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
- F. 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 becomes property of Contractor.

- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

- 1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.5 ACTION SUBMITTALS

- A. Waste Management Plan: Submit plan within 30 days of date established for commencement of the Work.

1.6 INFORMATIONAL SUBMITTALS

- A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Use forms provided by Design-Builder. Include the following information:
 - 1. Material category.
 - 2. Generation point of waste.
 - 3. Total quantity of waste in **tons (tonnes)**.
 - 4. Quantity of waste salvaged, both estimated and actual in **tons (tonnes)**.
 - 5. Quantity of waste recycled, both estimated and actual in **tons (tonnes)**.
 - 6. Total quantity of waste recovered (salvaged plus recycled) in **tons (tonnes)**.
 - 7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.
- B. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.
- C. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.
- D. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.
- E. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- F. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- G. Qualification Data: For waste management coordinator.

1.7 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with transportation and disposal regulations of authorities having jurisdiction.

1.8 WASTE MANAGEMENT PLAN

- A. Waste Identification: Indicate anticipated types and quantities of site-clearing and construction waste generated by the Work. Use forms provided by Design-Builder. Include estimated quantities and assumptions for estimates.
- B. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Use forms provided by Design-Builder. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.
 - 1. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
 - 2. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
 - 3. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.
- C. Cost/Revenue Analysis: Indicate total cost of waste disposal as if there were no waste management plan and net additional cost or net savings resulting from implementing waste management plan. Use forms provided by Design-Builder. Include the following:
 - 1. Total quantity of waste.
 - 2. Estimated cost of disposal (cost per unit). Include transportation and tipping fees and cost of collection containers and handling for each type of waste.
 - 3. Total cost of disposal (with no waste management).
 - 4. Revenue from salvaged materials.
 - 5. Revenue from recycled materials.
 - 6. Savings in transportation and tipping fees by donating materials.
 - 7. Savings in transportation and tipping fees that are avoided.
 - 8. Handling and transportation costs. Include cost of collection containers for each type of waste.
 - 9. Net additional cost or net savings from waste management plan.

PART 2 - PRODUCTS

- 1. Construction Waste:
 - a. Masonry and CMU.
 - b. Lumber.
 - c. Wood sheet materials.
 - d. Wood trim.
 - e. Metals.
 - f. Roofing.
 - g. Insulation.
 - h. Carpet and pad.
 - i. Gypsum board.
 - j. Piping.
 - k. Electrical conduit.

1. Packaging: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following uncontaminated packaging materials:
 - 1) Paper.
 - 2) Cardboard.
 - 3) Boxes.
 - 4) Plastic sheet and film.
 - 5) Polystyrene packaging.
 - 6) Wood crates.
 - 7) Wood pallets.
 - 8) Plastic pails.
- m. Construction Office Waste: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following construction office waste materials:
 - 1) Paper.
 - 2) Aluminum cans.
 - 3) Glass containers.

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

- A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
 1. Comply with operation, termination, and removal requirements in Section 015000 "Temporary Facilities and Controls."
- B. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.
 1. Distribute waste management plan to everyone concerned within three days of submittal return.
 2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.
- C. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged and recycled.
 2. Comply with Section 015000 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.2 RECYCLING 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. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
 - 4. Store components off the ground and protect from the weather.
 - 5. Remove recyclable waste from Owner's property and transport to recycling receiver or processor as often as required to prevent overfilling bins.

3.3 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.

3.4 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. General: Except for items or materials to be salvaged or recycled, remove waste materials and legally dispose of at designated spoil areas on Owner's property.
- C. 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. Inspection procedures.
 - 2. Project Record Documents.
 - 3. Operation and maintenance manuals.
 - 4. Warranties.
 - 5. Final cleaning.
 - 6. Final completion procedures.
 - 7. Instruction of Owner's personnel.
- B. Related Requirements:
 - 1. Section 012900 "Payment Procedures" for requirements for Applications for Payment for Substantial Completion and Final Completion.
 - 2. Section 013233 "Photographic Documentation" for submitting Final Completion construction photographic documentation.
 - 3. Section 017823 "Operation and Maintenance Data" for additional operation and maintenance manual requirements.
 - 4. Section 017839 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
 - 5. 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 Substantial Completion.
- 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.
- C. Field Report: For pest-control inspection.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Schedule of Maintenance Material Items: For maintenance material submittal items required by other Sections.

1.6 PRELIMINARY SUBMISSIONS

- A. Operations and Maintenance Submission at 80% Billing.
 - 1. Submit the following for approval prior to requesting a final review for Certification of Substantial Completion and prior to submitting an application for payment that shows the work to be 80% complete:
 - a. Bind operations and maintenance manuals, mechanical, electrical and operational diagrams and specific warranties in three (3) copies for Owner and Designer review.
 - b. Provide digital PDF version of documents for review.
 - c. Bind all documents in 3-ring binders.
 - d. Type identifying labels behind clear plastic on edge of binder.
 - e. Organize contents with marked reinforced index tabs, formatted to match the Specification Sections.

1.7 SUBSTANTIAL COMPLETION PROCEDURES

- A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's "punch list"), indicating the value of each item on the list and reasons why the Work is incomplete.
- B. Submittals Prior to Final Acceptance: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
 - 1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction, permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 - 2. Submit closeout submittals specified in other Division 01 Sections, including Project Record Documents, operation and maintenance manuals, damage or settlement surveys, property surveys, and similar final record information.
 - 3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.

4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Architect or Design-Builder. Label with manufacturer's name and model number.
 - a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Design-Builder's signature for receipt of submittals.
 5. Submit testing, adjusting, and balancing records.
 6. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
- C. Procedures Prior to Substantial Completion: Complete the following a minimum of [10] days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
 2. Project Observation Reports: Contractor will maintain a 3-ring binder of Architect's reports at the site. Contractor will correct individual non-complying items in report plus all reported or unreported instances of similar items throughout the jobsite within 30 days of report issuance. Contractor will document correction of each item by initialing approval, dating and sending Architect copy of initialed items. Continued failure to correct non-complying items will result in increased retainage. Final review for Substantial Completion cannot be scheduled until all reported items are in compliance.
 3. It is the Contractor's responsibility to manage the proper structural and technical installation of all exposed finishes. The Contractor must also assure the quality of the workmanship for all finishes.
 4. Advise Owner of pending insurance changeover requirements.
 5. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications and similar documents.
 6. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 7. Prepare and submit Project Record Documents, operation and maintenance manuals, Final Completion construction photographs or settlement surveys, property surveys, and similar final record information.
 8. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
 9. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
 10. Complete startup and testing of systems and equipment.
 11. Submit test/adjust/balance records.
 12. Perform preventive maintenance on equipment used prior to Substantial Completion.
 13. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 017900 "Demonstration and Training."
 14. Advise Owner of changeover in utility services.

15. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
 16. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 17. Complete final cleaning requirements.
 18. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect and Design-Builder will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.
1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
 2. Results of completed inspection will form the basis of requirements for Final Completion.

1.8 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 in accordance with Section 012900 "Payment Procedures."
 2. Submit an updated final statement, accounting for final additional changes to the Contract Sum.
 3. Submit final meter readings for utilities, a measured record of stored fuel, and similar data as of the date of Substantial Completion or when the Owner took possession of and assumed responsibility for corresponding elements of the Work.
 4. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
 5. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 6. Submit Consent of Surety to Final Payment.
 7. Submit a final liquidated damages settlement statement.
 8. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 9. Submit pest-control final inspection report.
 10. Submit Final Completion photographic documentation.
- B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect and Design-Builder will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment

after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.9 LIST OF INCOMPLETE ITEMS

- 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 and proceeding from lowest floor to highest floor, listed by room or space number.
 2. Organize items applying to each space by major element, including categories for ceilings, 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.
 - d. Name of Contractor.
 - e. Page number.

1.10 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 Substantial Completion, 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.
- 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 (215-by-280-mm) 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.
1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

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.
1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
 - a. Clean Project site of rubbish, waste material, litter, and other foreign substances.
 - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - c. Rake grounds that are not planted, mulched, or paved to a smooth, even-textured surface.
 - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - e. Remove snow and ice to provide safe access to building.
 - f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural

weathering of exterior surfaces. Restore reflective surfaces to their original condition.

- g. Remove debris and surface dust from limited-access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
 - h. Clean flooring, removing debris, dirt, and staining; clean according to manufacturer's recommendations.
 - i. Vacuum and mop concrete.
 - j. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
 - k. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
 - l. Remove labels that are not permanent.
 - m. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - n. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 - o. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - p. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.
 - q. Clean luminaires, lamps, globes, and reflectors to function with full efficiency.
 - r. Clean strainers.
 - s. Leave Project clean and ready for occupancy.
- C. Pest Control: Comply with pest control requirements in Section 015000 "Temporary Facilities and Controls." Prepare written report.
- D. Construction Waste Disposal: Comply with waste-disposal requirements in Section 015000 "Temporary Facilities and Controls." And Section 017419 "Construction Waste Management and Disposal."

3.2 REPAIR OF THE WORK

- A. Complete repair and restoration operations required by Section 017300 "Execution" before requesting inspection for determination of Substantial Completion.

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 Substantial Completion 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 (215-by-280-mm) 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 Text: Prepared on 8-1/2-by-11-inch (215-by-280-mm) 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 two paper-copy set(s) of marked-up record prints.
 - 2) Submit PDF electronic files of scanned record prints and one set(s) of file prints.
 - 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 prints 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. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Architect and Construction Manager. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:
1. Format: Same digital data software program, version, and operating system as for the original Contract Drawings.
 2. Format: Annotated PDF electronic file with comment function enabled.
 3. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
 4. Refer instances of uncertainty to Architect through Construction Manager for resolution.
 5. Architect will furnish Contractor with one set of digital data files of the Contract Drawings for use in recording information.
 - a. See Section 013100 "Project Management and Coordination" for requirements related to use of Architect's digital data files.
 - b. Architect will provide data file layer information. Record markups in separate layers.
- C. 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 with comment function enabled.
 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. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
3. For each principal product, indicate whether Record Product Data has been submitted in operation and maintenance manuals instead of submitted as Record Product Data.
4. 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. Attendance Record: For each training module, submit list of participants and length of instruction time.

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 paper and 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.

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 Architect and 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. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a demonstration performance-based test.
- F. Cleanup: Collect used and leftover educational materials and remove from Project site. 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 **MP4** format, produced by a digital camera with minimum sensor resolution of 12 megapixels and capable of recording in full HD mode.
 - 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.
- E. Narration: Describe scenes on video recording by audio narration by microphone while video recording is recorded. Include description of items being viewed.
- F. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.
- G. Preproduced Video Recordings: Provide video recordings used as a component of training modules in same format as recordings of live training.

PART 2 - PRODUCTS

PART 3 - EXECUTION

END OF SECTION 017900

SECTION 019913 - GENERAL REQUIREMENTS FOR DIVISIONS 21-27 WORK

The "Engineer of Record" for the work defined by Division 01 Sections 019913, 019919, and 019926 is Salas O'Brien, 702 Oberlin Road, Suite 300, Raleigh, NC, (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.



The "Engineer of Record" for the work defined by Divisions 21-27 is Salas O'Brien., 702 Oberlin Road, Suite 300, Raleigh, NC, (919) 832-8118. The term "engineer," "architect-engineer," "engineer-architect," "A-E," "E-A," etc., when used in Divisions 21-27 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 21-27, 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.

1 **DEFINITIONS**

2
3 Mechanical Work: Work required by this Contract as defined by specification Division 21 (Fire Protection), Division
4 22 (Plumbing), and Division 23 (Heating, Ventilating, and Air-Conditioning).

5
6 Electrical Work: Work required by this Contract as defined by specification Divisions 26-27.

7
8 Labeled: Appliances, equipment, materials or products to which has been attached a label, symbol, or other
9 identifying mark of an organization acceptable to the North Carolina Building Code Council and concerned with
10 product evaluation, that maintains periodic inspection of production of labeled equipment or materials and by whose
11 labeling the manufacturer indicates compliance with identified standards or has been tested and found suitable for a
12 specified purpose.

13
14 Listed: Appliances, equipment, materials or products included in a list published by an organization acceptable to the
15 North Carolina Building Code Council and concerned with product evaluation, that maintains periodic inspection of
16 production of listed equipment or materials, and whose listing states either that the equipment or material meets
17 appropriate designated standards or has been tested and found suitable for a specified purpose.

18
19 Concealed: Work within or behind various construction elements or in crawl spaces or trenches that is not exposed
20 to view when the project is complete.

21
22 Exposed: Not "concealed" as defined above, or anything exposed to view when the project is complete.

23
24 Wiring: Cable, raceways, fittings, mechanical supports, wire, junction boxes, device boxes, outlet boxes, switches,
25 cutouts, and related items.

26
27
28 **CODES, LAWS, REGULATIONS, AND STANDARDS**

29
30 Work on and for the project shall conform to requirements of each applicable volume of the *North Carolina Building*
31 *Code*; shall comply with the regulations of the N.C. Department of Labor, including the latest revisions and
32 interpretations of the *Occupational Safety and Health Act of North Carolina*; and be in accordance with all other
33 codes, laws, rules and regulations that apply to this project.

34
35 "Confined spaces" and "permit-requiring confined spaces", as defined by U.S. Occupational Safety and Health
36 Administration (USOSHA) may exist in the work area or may be created by the construction of this Project. The
37 Contractor shall be responsible for identification of any permit-requiring confined spaces and for establishing all
38 required procedures for meeting the requirements of USOSHA relative to these spaces, including written confined
39 space entry program(s).

40
41 Codes, laws, regulations, and/or industry standards referenced in the Specification or on the Drawings shall be
42 considered to be part of the Project requirements. Applicable edition of the referenced volume is the edition that
43 is/was in effect at the time the construction permit was issued or at the time of approval of the Contract Documents by
44 the Authority Having Jurisdiction.

45
46
47 **INTENT AND WORKMANSHIP**

48
49 The words "furnish," "furnish and install," "install," and "provide" or words with similar meaning shall be interpreted,
50 unless otherwise specifically stated, to mean "furnish and install complete in-place and ready for service."

51
52 The work of all trades under this Contract shall be coordinated in such a manner as to obtain the best workmanship
53 possible.

54
55 Miscellaneous items and accessories that are not specifically shown on the drawings or specified herein, but which
56 are essential to produce a complete and properly operating installation, or usable structure or plant, providing the
57 indicated function, shall be furnished and installed without change in the Contract price. Such miscellaneous items
58 and accessories shall be of the same quality standards, including material, style, finish, strength, class, weight and
59 other applicable characteristics, as specific for the major component of which the miscellaneous item or accessory is
60 an essential part. The above requirement, however, is not intended to include major components not covered by or
61 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.

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.

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.

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.

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.

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 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.

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.

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.

- 1 Keep interior spaces reasonably clean and protected from water damage.
- 2
- 3 Periodically collect and remove waste containing cellulose or other organic matter.
- 4 Discard or replace water-damaged material.
- 5
- 6 Do not install material that is wet.
- 7
- 8 Discard, replace, or clean stored or installed material that begins to grow mold.
- 9
- 10 Perform work in a sequence that allows any wet materials adequate time to dry before enclosing the
- 11 material in drywall or other interior finishes.
- 12
- 13 Controlled Construction Phase of Construction: After completing and sealing of the building enclosure, maintain as
- 14 follows:
- 15
- 16 Control moisture and humidity inside building by maintaining effective dry-in conditions.
- 17
- 18 Use **temporary** HVAC units or system to control humidity.
- 19
- 20 Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water
- 21 limits.
- 22
- 23 Hygroscopic materials that may support mold growth that become wet during the course of construction and
- 24 remain wet for 48 hours are considered defective and must be replaced.
- 25
- 26

DUST AND CONTAMINATION CONTROL DURING CONSTRUCTION

- 27
- 28
- 29 Prevent dust, fumes, and odors from entering occupied areas or areas in which construction work is more advanced
- 30
- 31 Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by
- 32 Owner from fumes and noise. Construct dustproof partitions with two layers of 6-mil polyethylene sheet on each
- 33 side. Cover floor with two layers of 6-mil polyethylene sheet, extending sheets 18 inches up the sidewalls.
- 34 Overlap and tape full length of joints. Cover floor with fire-retardant-treated plywood.
- 35
- 36 Maintain negative air pressure within the work area using HEPA-equipped air-filtration units, starting with
- 37 commencement of temporary partition construction, and continuing until removal of temporary partitions is
- 38 complete.
- 39
- 40 Use vacuum collection attachments on dust-producing equipment. Isolate limited work areas using portable dust-
- 41 containment devices.
- 42
- 43 Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.
- 44
- 45 Coordinate general construction activities with the work of Divisions 21-27 to avoid contamination and/or degradation
- 46 of building engineered systems by dust, over-spray of insulation or paint, etc. **Costs for the cleaning and/or**
- 47 **component replacement of engineered systems required by contamination and/or degradation by general**
- 48 **construction activities shall be assigned to the General Contractor.**
- 49
- 50

TEMPORARY HVAC SYSTEMS USE DURING CONSTRUCTION

- 51
- 52
- 53 **The use of permanent HVAC systems to support construction activities is prohibited.** The need for heating,
- 54 cooling, dehumidification, and/or ventilation during construction shall be met via use of temporary HVAC units or
- 55 systems as follows:
- 56
- 57 Heating: Provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space
- 58 thermostatic control. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type
- 59 heating units is prohibited.
- 60
- 61 Cooling: Provide modular, portable stand-alone direct expansion cooling units with condensers vented to the
- 62 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.**

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 21-27 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.

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.

- 1 Cross-reference record prints to corresponding archive photographic documentation.
2
3 Types of items requiring marking include, but are not limited to, the following:
4
5 Dimensional changes.
6
7 Revisions to details.
8
9 Locations and depths of underground utilities.
10
11 Revisions to routing of piping and conduits.
12
13 Revisions to electrical circuitry.
14
15 Actual equipment locations.
16
17 Duct size and routing.
18
19 Locations of concealed internal utilities.
20
21 Additional information that was either shown schematically or omitted from original Drawings.
22
23 Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar
24 identification, where applicable.
25
26 Submit Contractor As-built Drawings to A/E for review **at least two (2) weeks prior to Project final inspection.**
27
28
29 **END SECTION 019913**

SUBMITTAL COVER FORM

PROJECT: Eastern Wake Site Fire and Rescue Training Center
Wake Technical Community College

PROJECT NO.: 2023-00520

TO: SALAS O'BRIEN
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

SECTION 019919 - EXCAVATION FOR DIVISIONS 21 - 27 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 21-27, 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 21-27.

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 1/2" 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.

1 Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the
2 full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling
3 with utilities testing.
4

5 Install warning tape directly above utilities, 12 inches below finished grade. See Sections 221125 and
6 221126 for special underground gas piping identification requirements, as applicable.
7

8
9 **DISPOSAL OF SURPLUS AND WASTE MATERIALS**

10
11 Remove surplus soil and waste materials, including unsatisfactory soil, trash, and construction debris, and legally
12 dispose of them off Owner's property.
13

14
15 **END OF SECTION 019919**

SECTION 019926 - OWNER INSTRUCTION AND TRAINING FOR DIVISIONS 21-27 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 21-27, 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 21-27, 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 21-27 system, subsystem, and equipment item, including both classroom instruction and "hands-on" demonstrations.

1 Training Modules: Develop a learning objective and teaching outline for each instruction and training module, taking
2 into consideration the level of proficiency of Owner's maintenance staff. Include a description of specific skills and
3 knowledge that each participant is expected to master.

4
5 For each instruction and training module, include instruction for the following, as applicable to the system, subsystem,
6 equipment, or component:

7
8 **Documentation:** Review the following items in detail:

9
10 Operations manuals.

11
12 Maintenance manuals.

13
14 Project record documents.

15
16 Warranties, bonds, and guarantees.

17
18 Maintenance service agreements and similar continuing commitments.

19
20 **Emergencies:** Include the following, as applicable:

21
22 Instructions on meaning of warnings, trouble indications, and error messages.

23
24 Shutdown instructions for each type of emergency.

25
26 Operating instructions for conditions outside of normal operating limits.

27
28 Sequences for electric or electronic control systems.

29
30 Special operating instructions and procedures.

31
32 **Operations:** Include the following, as applicable:

33
34 Startup procedures.

35
36 Equipment or system break-in procedures.

37
38 Routine and normal operating instructions.

39
40 Regulation and control procedures.

41
42 **Control sequences.**

43
44 Safety procedures.

45
46 Normal start-up and shutdown instructions.

47
48 Operating procedures for emergencies.

49
50 Operating procedures for system, subsystem, or equipment failure.

51
52 Required sequences for electric or electronic control systems.

53
54 Special operating instructions and procedures.

55
56 **Adjustments:** Include the following:

57
58 Alignments.

59
60 Routine adjustments, tightening, etc.

61
62 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 031000 - CONCRETE FORMING 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. Form-facing material for cast-in-place concrete.
 - 2. Shoring, bracing, and anchoring.

1.3 DEFINITIONS

- A. Form-Facing Material: Temporary structure or mold for the support of concrete while the concrete is setting and gaining sufficient strength to be self-supporting.
- B. Formwork: The total system of support of freshly placed concrete, including the mold or sheathing that contacts the concrete, as well as supporting members, hardware, and necessary bracing.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference:
 - 1. Review the following:
 - a. Special inspection and testing and inspecting agency procedures for field quality control.
 - b. Construction, movement, contraction, and isolation joints
 - c. Forms and form-removal limitations.
 - d. Shoring and reshoring procedures.
 - e. Anchor rod and anchorage device installation tolerances.

1.5 QUALITY ASSURANCE

- A. Testing and Inspection Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Concrete Formwork: Design, engineer, erect, shore, brace, and maintain formwork, shores, and reshores in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.
1. Design wood panel forms in accordance with APA's "Concrete Forming Design/Construction Guide."
 2. Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing of supports.
- B. Design, engineer, erect, shore, brace, and maintain insulating concrete forms in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.
1. Design cross ties to transfer the effects of the following loads to the cast-in-place concrete core:
 - a. Wind Loads: As indicated on Drawings.
 - 1) Horizontal Deflection Limit: Not more than 1/240 of the wall height.

2.2 FORM-FACING MATERIALS

- A. As-Cast Surface Form-Facing Material:
1. Provide continuous, true, and smooth concrete surfaces.
 2. Furnish in largest practicable sizes to minimize number of joints.
 3. Acceptable Materials: As required to comply with Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete, and as follows:
 - a. Plywood, metal, or other approved panel materials.
 - b. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
 - 1) APA HDO (high-density overlay).
 - 2) APA MDO (medium-density overlay); mill-release agent treated and edge sealed.
 - 3) APA Structural 1 Plyform, B-B or better; mill oiled and edge sealed.
 - 4) APA Plyform Class I, B-B or better; mill oiled and edge sealed.

- B. Concealed Surface Form-Facing Material: Lumber, plywood, metal, plastic, or another approved material.

1. Provide lumber dressed on at least two edges and one side for tight fit.

2.3 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.

2.4 RELATED MATERIALS

- A. Reglets: Fabricate reglets of not less than 0.022-inch- thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.
- B. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.
- C. Form-Release Agent: Commercially formulated form-release agent that does 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.
 2. Form release agent for form liners shall be acceptable to form liner manufacturer.
- D. Form Ties: Factory-fabricated, removable or snap-off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
1. Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
 2. Furnish ties that, when removed, 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.

PART 3 - EXECUTION

3.1 INSTALLATION OF FORMWORK

- A. Comply with ACI 301.
- B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 and to comply with the Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete" for as-cast finishes.
- C. Limit concrete surface irregularities as follows:

-
1. Surface Finish-2.0: ACI 117 Class B, 1/4 inch.
 2. Surface Finish-3.0: ACI 117 Class A, 1/8 inch.
- D. Construct forms tight enough to prevent loss of concrete mortar.
1. Minimize joints.
 2. Exposed Concrete: Symmetrically align joints in forms.
- E. Construct removable forms for easy removal without hammering or prying against concrete surfaces.
1. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.
 2. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 3. Install keyways, reglets, recesses, and other accessories, for easy removal.
- F. Do not use rust-stained, steel, form-facing material.
- G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.
1. Provide and secure units to support screed strips
 2. Use strike-off templates or compacting-type screeds.
- H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.
1. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
 2. Locate temporary openings in forms at inconspicuous locations.
- I. Chamfer exterior corners and edges of permanently exposed concrete.
- J. At construction joints, overlap forms onto previously placed concrete not less than 12 inches.
- K. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.
1. Determine sizes and locations from trades providing such items.
 2. Obtain written approval of Architect prior to forming openings not indicated on Drawings.
- L. Construction and Movement Joints:
1. Construct joints true to line with faces perpendicular to surface plane of concrete.
 2. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 3. Place joints perpendicular to main reinforcement.
 4. Locate joints for beams, slabs, joists, and girders in the middle third of spans.
 - a. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.

5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 6. Space vertical joints in walls as indicated on Drawings .
 - a. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
- M. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.
1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
 2. Close temporary ports and openings with tight-fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.
- N. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- O. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- P. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 INSTALLATION OF EMBEDDED ITEMS

- 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.
1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
 3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
 4. Clean embedded items immediately prior to concrete placement.

3.3 INSTALLATION OF WATERSTOPS

- A. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated on Drawings, according to manufacturer's written instructions, by adhesive bonding, mechanically fastening, and firmly pressing into place.
1. Install in longest lengths practicable.
 2. Locate waterstops in center of joint unless otherwise indicated on Drawings.
 3. Protect exposed waterstops during progress of the Work.

3.4 REMOVING AND REUSING FORMS

- A. Formwork that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations. Curing and protection operations need to be maintained at unformed surfaces and applied at formed surfaces immediately after removal of forms, for the remainder of the curing period.
- B. Clean and repair surfaces of forms to be reused in the Work.
 - 1. Split, frayed, delaminated, or otherwise damaged form-facing material are unacceptable for exposed surfaces.
 - 2. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints.
 - 1. Align and secure joints to avoid offsets.
 - 2. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

END OF SECTION 031000

SECTION 032000 - CONCRETE REINFORCING

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 reinforcement bars.
 - 2. Welded-wire reinforcement.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference:
 - 1. Review the following:
 - a. Special inspection and testing and inspecting agency procedures for field quality control.
 - b. Construction contraction and isolation joints.
 - c. Steel-reinforcement installation.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Each type of steel reinforcement.
 - 2. Bar supports.
- B. Shop Drawings: Comply with ACI SP-066:
 - 1. Include placing drawings that detail fabrication, bending, and placement.
 - 2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.
- C. Construction Joint Layout: Indicate proposed construction joints required to build the structure.
 - 1. Location of construction joints is subject to approval of the Architect.

1.5 INFORMATIONAL SUBMITTALS

- A. Material Test Reports: For the following, from a qualified testing agency:
 - 1. Steel Reinforcement:
 - a. For reinforcement to be welded, mill test analysis for chemical composition and carbon equivalent of the steel in accordance with ASTM A706/A706M.
 - 2. Mechanical splice couplers.
- B. Field quality-control reports.
- C. Minutes of preinstallation conference.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.
- B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.4/D 1.4M.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.
 - 1. Store reinforcement to avoid contact with earth.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.
 - 1. Steel Bars: ASTM A615/A615M, Grade 60, deformed bars.
- B. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.

2.2 REINFORCEMENT ACCESSORIES

- A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.

1. Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

- a. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.

- B. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch in diameter.

1. Finish: Plain.

2.3 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protection of In-Place Conditions:
 1. Do not cut or puncture vapor retarder.
 2. 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.

3.2 INSTALLATION OF STEEL REINFORCEMENT

- A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.
- B. Accurately position, support, and secure reinforcement against displacement.
 1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
 2. Do not tack weld crossing reinforcing bars.
- C. Preserve clearance between bars of not less than 1 inch, not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.
- D. Provide concrete coverage in accordance with ACI 318.
- E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- F. Splices: Lap splices as indicated on Drawings.

1. Bars indicated to be continuous, and all vertical bars shall be lapped not less than 36 bar diameters at splices, or 24 inches, whichever is greater.
2. Stagger splices in accordance with ACI 318.
3. Mechanical Splice Couplers: Install in accordance with manufacturer's instructions.
4. Weld reinforcing bars in accordance with AWS D1.4/D 1.4M, where indicated on Drawings.

G. Install welded-wire reinforcement in longest practicable lengths.

1. Support welded-wire reinforcement in accordance with CRSI "Manual of Standard Practice."
 - a. For reinforcement less than W4.0 or D4.0, continuous support spacing shall not exceed 12 inches.
2. Lap edges and ends of adjoining sheets at least one wire spacing plus 2 inches for plain wire and 8 inches for deformed wire.
3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
4. Lace overlaps with wire.

3.3 JOINTS

- A. 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.
 2. Continue reinforcement across construction joints unless otherwise indicated.

3.4 INSTALLATION TOLERANCES

- A. Comply with ACI 117.

3.5 SPECIAL INSPECTIONS

- A. Special Inspections: Owner will engage a special inspector to perform tests and inspections and prepare reports.
- B. Verification and inspection of concrete reinforcing shall be in accordance with Virginia Construction Code 2018 and the Schedule of Special Inspections and as follows:
- C. Inspections:
1. Steel-reinforcement placement including reinforcing size, quantity, spacing, clearances, cleanliness and lap lengths.
- 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.

END OF SECTION 032000

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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 031000 "Concrete Forming and Accessories" for form-facing materials, form liners, insulating concrete forms, and waterstops.
 - 2. Section 032000 "Concrete Reinforcing" for steel reinforcing bars and welded-wire reinforcement.
 - 3. Section 079513.13 "Interior Expansion Joint Cover Assemblies" for floor expansion joints requiring recesses in concrete floor slabs.
 - 4. Section 312100 "Earthwork for Buildings" 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:

- 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.

2. Review 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. Curing of test cylinders in field and laboratory.

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 retarders.
6. Curing materials.
7. Repair materials.

B. Design Mixtures: For each concrete mixture, include the following:

1. Mixture identification.
2. Minimum 28-day compressive strength.
3. Durability exposure class.
4. Maximum w/cm.
5. Calculated equilibrium unit weight, for lightweight concrete.
6. Slump limit.
7. Air content.
8. Nominal maximum aggregate size.
9. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
10. Include manufacturer's certification that permeability-reducing admixture is compatible with mix design.

11. Include certification that dosage rate for permeability-reducing admixture matches dosage rate used in performance compliance test.
12. Intended placement method.
13. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Shop Drawings:

1. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
 - a. Location of construction joints is subject to approval of the Architect.

D. Concrete Schedule: For each location of each Class of concrete indicated in "Concrete Mixtures" Article, including the following:

1. Concrete Class designation.
2. Location within Project.
3. Exposure Class designation.
4. Formed Surface Finish designation and final finish.
5. Final finish for floors.
6. Curing process.
7. Floor treatment if any.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

1. Ready-mixed concrete manufacturer.
2. Testing agency: Include copies of applicable ACI certificates.

B. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Curing compounds.
4. Floor and slab treatments.
5. Bonding agents.
6. Adhesives.
7. Vapor retarders.
8. Repair materials.

C. Material Test Reports: For the following, from a qualified testing agency:

1. Portland cement.
2. Fly ash.
3. Aggregates.
4. Admixtures:

D. Floor surface flatness and levelness measurements report, indicating compliance with specified tolerances.

- E. Research Reports:
 - 1. For concrete admixtures in accordance with ICC's Acceptance Criteria AC198.
 - 2. For sheet vapor retarder/termite barrier, showing compliance with ICC AC380.
- F. Preconstruction Test Reports: For each mix design.
- G. Field quality-control reports.
- H. Minutes of preinstallation conference.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs Project personnel qualified as an ACI-certified Flatwork Technician and Finisher and a supervisor who is a certified ACI Flatwork Concrete Finisher/Technician or an ACI Concrete Flatwork Technician with experience installing and finishing concrete, incorporating permeability-reducing admixtures.
 - 1. Post-Installed Concrete Anchors Installers: ACI-certified Adhesive Anchor Installer.
- B. Ready-Mixed 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 in accordance with NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- C. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated and employing an ACI-certified Concrete Quality Control Technical Manager.
 - 1. Personnel performing laboratory tests shall be an 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. Field Quality Control Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.
 - 1. Personnel conducting field tests shall be qualified as an ACI Concrete Field Testing Technician, Grade 1, in accordance with ACI CPP 610.1 or an equivalent certification program.

1.8 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on each concrete mixture.

1. Include the following information in each test report:
 - a. Slump.
 - b. Air content.
 - c. Water-Cement ratio.
 - d. Seven-day compressive strength.
 - e. 28-day compressive strength.
 - f. Standard deviation.
 - g. ACI required compressive strength.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Comply with ASTM C94/C94M and ACI 301.

1.10 FIELD CONDITIONS

- A. Cold-Weather Placement: Comply with ACI 301 and ACI 306.1 and as follows.

1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
2. 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 301.
3. Do not use frozen materials or materials containing ice or snow.
4. Do not place concrete in contact with surfaces less than 35 deg F, other than reinforcing steel.
5. 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 301 and ACI 305.1, and as follows:

1. Maintain concrete temperature at time of discharge to not exceed 95 deg F.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

1.11 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to furnish replacement sheet vapor retarder/termite barrier material and accessories for sheet vapor retarder/ termite barrier and accessories that do not comply with requirements or that fail to resist penetration by termites within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with ACI 301 unless modified by requirements in the Contract Documents.

2.2 CONCRETE MATERIALS

- A. Source Limitations:

- 1. Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.
 - 2. Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant.
 - 3. Obtain aggregate from single source.
 - 4. Obtain each type of admixture from single source from single manufacturer.

- B. Cementitious Materials:

- 1. Portland Cement: ASTM C150/C150M, Type I/II, gray.
 - 2. Fly Ash: ASTM C618, Class C or F.

- C. Normal-Weight Aggregates: ASTM C33/C33M, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source.

- 1. Alkali-Silica Reaction: Comply with one of the following:
 - a. Expansion Result of Aggregate: Not more than 0.04 percent at one-year when tested in accordance with ASTM C1293.
 - b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567.
 - c. Alkali Content in Concrete: Not more than 4 lb./cu. yd. for moderately reactive aggregate or 3 lb./cu. yd. for highly reactive aggregate, when tested in accordance with ASTM C1293 and categorized in accordance with ASTM C1778, based on alkali content being calculated in accordance with ACI 301.
 - 2. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
 - 3. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

- D. Air-Entraining Admixture: ASTM C260/C260M.

- E. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures that do 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 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.

- F. Water and Water Used to Make Ice: ASTM C94/C94M, potable.

2.3 VAPOR RETARDERS

- A. Sheet Vapor Retarder, Class A: ASTM E1745, Class A; not less than 15 mils thick. Include manufacturer's recommended adhesive or pressure-sensitive tape.

2.4 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.

1. Color:

- a. Ambient Temperature Below 50 deg F: Black.
- b. Ambient Temperature between 50 deg F and 85 deg F: Any color.
- c. Ambient Temperature Above 85 deg F: White.

- D. Curing Paper: Eight-foot-wide paper, consisting of two layers of fibered kraft paper laminated with double coating of asphalt.
- E. Water: Potable or complying with ASTM C1602/C1602M.
- F. Clear, Waterborne, Membrane-Forming, Dissipating Curing Compound: ASTM C309, Type 1, Class B, certified by curing compound manufacturer to not interfere with bonding of floor covering.

2.5 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber or ASTM D1752, cork or self-expanding cork.
- B. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.
- C. Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade and class to suit requirements, and as follows:

1. Types I and II, nonload bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.6 REPAIR MATERIALS

- A. 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 C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
 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 in accordance with ASTM C109/C109M.

2.7 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, in accordance with ACI 301.
 1. Use a qualified 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:
 1. Fly Ash or Other Pozzolans: 25 percent by mass.
- C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.
 1. Use water-reducing 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.
 3. Use water-reducing admixture in pumped concrete and concrete with a w/cm below 0.50.
- D. Color Pigment: Add color pigment to concrete mixture in accordance with manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2.8 CONCRETE MIXTURES

- A. Class A: Normal-weight concrete used for footings, elevator pit walls and piers.
 1. Minimum Compressive Strength: 3000 psi at 28 days.

2. Slump Limit: 5 inches plus or minus 1 inch; or 8 inches plus or minus 1 inch for concrete with verified maximum slump of 4 inches before adding high-range water-reducing admixture or plasticizing admixture at Project site.
3. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

B. Class B: Normal-weight concrete used for interior slabs-on-ground.

1. Minimum Compressive Strength: 5000 psi at 28 days.
2. Minimum Cementitious Materials Content: 470 lb/cu. yd.
3. Slump Limit: 5 inches plus or minus 1 inch; or 8 inches plus or minus 1 inch for concrete with verified maximum slump of 4 inches before adding high-range water-reducing admixture or plasticizing admixture at Project site.
4. Air Content: 0.15
5. Limit water-soluble, chloride-ion content in hardened concrete to 1.00 percent by weight of cement.

2.9 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M, and furnish batch ticket information.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. Before placing concrete, verify that installation of concrete forms, accessories, and reinforcement, and embedded items is complete and that required inspections have been performed.
2. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:

1. Daily access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Secure space for storage, initial curing, and field curing of test samples, including source of water and continuous electrical power at Project site during site curing period for test samples.
4. Security and protection for test samples and for testing and inspection equipment at Project site.

3.3 INSTALLATION OF EMBEDDED ITEMS

- 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.
 - 1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of ANSI/AISC 303.
 - 3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

3.4 INSTALLATION OF VAPOR RETARDER

- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.
 - 1. Install vapor retarder with longest dimension parallel with direction of concrete pour.
 - 2. Face laps away from exposed direction of concrete pour.
 - 3. Lap vapor retarder over footings and grade beams not less than 6 inches, sealing vapor retarder to concrete.
 - 4. Lap joints 6 inches and seal with manufacturer's recommended tape.
 - 5. Terminate vapor retarder at the top of floor slabs and footings, sealing entire perimeter to floor slabs, footings and foundation walls.
 - 6. Seal penetrations in accordance with vapor retarder manufacturer's instructions.
 - 7. Protect vapor retarder during placement of reinforcement and concrete.
 - a. Repair damaged areas by patching with vapor retarder material, overlapping damages area by 6 inches on all sides, and sealing to vapor retarder.

3.5 JOINTS

- A. Construct joints true to line, with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.
 - 1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.
 - 2. Place joints perpendicular to main reinforcement.
 - a. Continue reinforcement across construction joints unless otherwise indicated.
 - b. Do not continue reinforcement through sides of strip placements of floors and slabs.
 - 3. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
 - 4. Space vertical joints in walls as indicated on Drawings. Unless otherwise indicated on Drawings, locate vertical 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. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-fourth of concrete thickness as follows:
 1. Sawed Joints: Form control 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 cracks.
- D. Isolation Joints in Slabs-on-Ground: 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 on Drawings.
 2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface, where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
 3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

3.6 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.
 1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
 2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.
- B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.
- C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect in writing, but not to exceed the amount indicated on the concrete delivery ticket.
 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301, but not to exceed the amount indicated on the concrete delivery ticket.
 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- E. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.

1. If a section cannot be placed continuously, provide construction joints as indicated.
 2. Deposit concrete to avoid segregation.
 3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
 4. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301.
 - a. Do not use vibrators to transport concrete inside forms.
 - b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer.
 - c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
 - d. 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.
- F. 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. Do not place concrete floors and slabs in a checkerboard sequence.
 2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 3. Maintain reinforcement in position on chairs during concrete placement.
 4. Screed slab surfaces with a straightedge and strike off to correct elevations.
 5. Level concrete, cut high areas, and fill low areas.
 6. Slope surfaces uniformly to drains where required.
 7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
 8. Do not further disturb slab surfaces before starting finishing operations.

3.7 FINISHING FORMED SURFACES

A. As-Cast Surface Finishes:

1. ACI 301 Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material.
 - a. Patch voids larger than 1-1/2 inches wide or 1/2 inch deep.
 - b. Remove projections larger than 1 inch.
 - c. Tie holes do not require patching.
 - d. Surface Tolerance: ACI 117 Class D.
 - e. Apply to concrete surfaces not exposed to public view.
2. ACI 301 Surface Finish SF-2.0: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.
 - a. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
 - b. Remove projections larger than 1/4 inch.
 - c. Patch tie holes.
 - d. Surface Tolerance: ACI 117 Class B.
 - e. Locations: Apply to concrete surfaces exposed to public view.

3. ACI 301 Surface Finish SF-3.0:

- a. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
- b. Remove projections larger than 1/8 inch.
- c. Patch tie holes.
- d. Surface Tolerance: ACI 117 Class A.
- e. Locations: Apply to concrete surfaces exposed to public view.

B. Related Unformed Surfaces:

1. At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a color and texture matching adjacent formed surfaces.
2. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.8 FINISHING FLOORS AND SLABS

A. Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Float Finish:

1. When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.
2. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture and complies with ACI 117 tolerances for conventional concrete.
3. Apply float finish to surfaces to receive trowel finish.

C. Trowel Finish:

1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
2. Continue troweling passes and restraighen until surface is free of trowel marks and uniform in texture and appearance.
3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
4. Do not add water to concrete surface.
5. Do not apply hard-troweled finish to concrete, which has a total air content greater than 3 percent.
6. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
7. Finish surfaces to the following tolerances, in accordance with ASTM E1155, for a randomly trafficked floor surface:
 - a. Slabs on Ground:
 - 1) 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.

- b. Suspended Slabs:
 - 1) 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.
- D. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Drawings.
 - 1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.
 - 2. Coordinate required final finish with Architect before application.

3.9 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

- A. Filling In:
 - 1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
 - 2. Mix, place, and cure concrete, as specified, to blend with in-place construction.
 - 3. 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 6 inches high unless otherwise indicated on Drawings, and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
 - 3. Minimum Compressive Strength: 3000 psi at 28 days.
 - 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
 - 6. Prior to pouring concrete, place and secure anchorage devices.
 - a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - b. Cast anchor-bolt insert into bases.
 - c. 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.
 - 1. Cast-in inserts and accessories, as shown on Drawings.
 - 2. Screed, tamp, and trowel finish concrete surfaces.

3.10 CONCRETE CURING

- A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

1. Comply with ACI 301 and ACI 306.1 for cold weather protection during curing.
2. Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.
3. Maintain moisture loss no more than 0.2 lb/sq. ft. x h before and during finishing operations.

B. Curing Formed Surfaces: Comply with ACI 308.1 as follows:

1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.
3. If forms remain during curing period, moist cure after loosening forms.
4. If removing forms before end of curing period, continue curing for remainder of curing period, as follows:
 - a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
 - b. Continuous Sprinkling: Maintain concrete surface continuously wet.
 - c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
 - d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.
 - e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
 - 1) Recoat areas subject to heavy rainfall within three hours after initial application.
 - 2) Maintain continuity of coating and repair damage during curing period.

C. Curing Unformed Surfaces: Comply with ACI 308.1 as follows:

1. Begin curing immediately after finishing concrete.
2. Interior Concrete Floors:
 - a. Floors to Receive Floor Coverings Specified in Other Sections: Contractor has option of the following:
 - 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
 - a) Lap edges and ends of absorptive cover not less than 12-inches.
 - b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
 - 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.

- a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
 - b) Cure for not less than seven days.
- 3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
- a) Water.
 - b) Continuous water-fog spray.

b. Floors to Receive Curing Compound:

- 1) Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
- 2) Recoat areas subjected to heavy rainfall within three hours after initial application.
- 3) Maintain continuity of coating, and repair damage during curing period.
- 4) 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.

3.11 TOLERANCES

- A. Conform to ACI 117.

3.12 CONCRETE SURFACE REPAIRS

A. Defective Concrete:

- 1. Repair and patch defective areas when approved by Architect.
- 2. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

- B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

- 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.
 - a. Limit cut depth to 3/4 inch.
 - b. Make edges of cuts perpendicular to concrete surface.
 - c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
 - d. Fill and compact with patching mortar before bonding agent has dried.

- e. 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 matches surrounding color.
 - a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
 - b. Compact mortar in place and strike off slightly higher than surrounding surface.
 3. Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance as determined by Architect.
- D. Repairing Unformed Surfaces:
 1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.
 - a. Correct low and high areas.
 - b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
 2. Repair finished surfaces containing surface defects, including 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.
 3. After concrete has cured at least 14 days, correct high areas by grinding.
 4. Correct localized low areas during, or immediately after, completing surface-finishing operations by cutting out low areas and replacing with patching mortar.
 - a. Finish repaired areas to blend into adjacent concrete.
 5. Correct other low areas scheduled to remain exposed with repair topping.
 - a. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations.
 - b. Prepare, mix, and apply repair topping and primer in accordance with 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.
 - a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a 3/4-inch clearance all around.
 - b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
 - c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
 - d. Place, compact, and finish to blend with adjacent finished concrete.
 - e. Cure in same manner as adjacent concrete.

7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar.
 - a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
 - b. Dampen cleaned concrete surfaces and apply bonding agent.
 - c. Place patching mortar before bonding agent has dried.
 - d. Compact patching mortar and finish to match adjacent concrete.
 - e. 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.

3.13 PROTECTION

- A. Protect concrete surfaces as follows:
 1. Protect from petroleum stains.
 2. Diaper hydraulic equipment used over concrete surfaces.
 3. Prohibit vehicles from interior concrete slabs.
 4. Prohibit use of pipe-cutting machinery over concrete surfaces.
 5. Prohibit placement of steel items on concrete surfaces.
 6. Prohibit use of acids or acidic detergents over concrete surfaces.

END OF SECTION 033000

**SECTION 03 30 00.01 - CAST-IN-PLACE CONCRETE - BURN BUILDING, TRAINING TOWER,
AND DRAFTING PIT**

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 specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mix designs, placement procedures, and finishes.
- B. Cast-in-place concrete includes the following:
 - 1. Foundations and footings.
 - 2. Slabs-on-grade.
 - 3. Building frame members.

1.3 SUBMITTALS

- A. General: Submit the following according to General Conditions of the Contract and Division 01 Specification Sections.
- B. Product data for each type of product, proprietary materials, and items, including reinforcement, forming accessories, admixtures, joint systems, and each type of product indicated, and others if requested by Engineer.
- C. Steel Reinforcement Shop Drawings: Submit placing drawings for reinforcement that detail fabrication, bending, and placement of concrete reinforcement. Comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures". Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, splices and laps, mechanical connections, tie spacing, bar arrangement, and supports for concrete reinforcement. Include special reinforcing required for openings through concrete structures.
- D. Formwork Shop Drawings: Signed and sealed by a qualified professional engineer; detailing fabrication, assembly, and support of formwork, including shoring.
 - 1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.
- E. Design Mixes: For each concrete mixture, submit laboratory test reports for concrete materials and mix design test. Provide all backup data, as required by ACI 301 and 318, for mix designs. Submit alternate design mixes when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments. The concrete mix design, trial batch

testing samples, and trial batch data/test results must use the same type of cement and admixtures that will be used for construction, then the concrete mix design, trial batch testing samples, and trial batch data/test results must also use Type IL cement.

1.4 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 requirements for production facilities and equipment.
- C. Codes and Standards: Comply with provisions of the following codes, specifications, and standards, except where more stringent requirements are shown or specified:
 - 1. American Concrete Institute (ACI) 301, "Specifications for Structural Concrete for Buildings."
 - 2. ACI 318, "Building Code Requirements for Reinforced Concrete."
 - 3. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
 - 4. ACI 347R, "Guide to Formwork for Concrete".
 - 5. ACI 347.3R "Guide to Formed Concrete Surfaces".
 - 6. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice."
- D. Concrete Testing Service: Owner will employ a qualified testing agency to perform material evaluation tests.
- E. Materials and installed work may require testing and retesting at any time during progress of Work. Retesting of rejected materials for installed Work, shall be done at Contractor's expense.
- F. 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.
- G. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Division 01 Section "Project Management and Coordination" and the following:
 - 1. At least 14 days prior to submitting design mixes, conduct a meeting to review detailed requirements for preparing concrete design mixes and to determine procedures for ensuring satisfactory concrete operations and quality of concrete materials. Review requirements for submittals, concrete finishes and finishing, status of coordinating work, and availability of materials. Establish preliminary work progress schedule and procedures for materials inspection, testing, and certifications. Require representatives of each entity directly concerned with cast-in-place concrete to attend conference, including, but not limited to, the following:
 - a. Contractor's superintendent.
 - b. Agency responsible for concrete design mixes.
 - c. Agency responsible for field quality control.
 - d. Ready-mix concrete producer.

- e. Concrete subcontractor.
 - f. Primary admixture manufacturers.
- H. Mockups: Cast concrete formed wall surface panel for each type of wall to demonstrate typical joints, surface finish, texture, tolerances, and standard of workmanship
 - 1. Build each formed wall panel approximately 100 sq. ft. surface in a location on site acceptable to Engineer.
- 1.5 DELIVERY, STORAGE, AND HANDLING
 - A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.
- 1.6 FIELD CONDITIONS
 - A. Cold-Weather Placement: Comply with provisions of 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 301.
 - 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 mix designs.
 - B. Hot-Weather Placement: When hot weather conditions exist that would impair quality and strength of concrete, comply with ACI 301 and as follows
 - 1. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90 deg F. Mixing water may be chilled 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. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
 - 3. Fog spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots or dry areas.
 - 4. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to Engineer.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces required in Part 3 of this specification. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings (if any).
 - 1. Metal panels.
 - 2. Exterior grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
 - a. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
- B. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch minimum or as indicated in drawings.
- C. Form-Release Agent: Provide commercially formulated form-release agent with a maximum of 350 g/L volatile organic compounds (VOCs) that does not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
 - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- D. Form Ties: Factory-fabricated, adjustable-length, removable or snap-off glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete upon removal.
 - 1. Provide units that will leave no corrodible metal closer than 1-1/2 inches to the plane of the exposed concrete surface.
 - 2. Provide ties that, when removed, will leave holes not larger than 1 inch in diameter in the concrete surface.

2.2 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615 Grade 60, deformed (ASTM A 706, deformed, Low-Alloy Steel Reinforcing Bars for any rebar that is welded).
- B. Plain-Steel Wire: ASTM A 1064, as drawn.
- C. Plain Steel Welded-Wire Reinforcement: ASTM A 1064, plain, fabricated from as-drawn steel wire into flat sheets.

2.3 REINFORCEMENT ACCESSORIES

- A. Supports for Reinforcement: 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 according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
 - 1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.

2. For concrete surfaces exposed to view, where legs of wire bar supports are in contact with forms, provide CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.

2.4 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I.
 1. Use one type, brand and source of cement throughout Project.
- B. Fly Ash: ASTM C 618, Type F.
- C. Slag Cement: ASTM C989/C989M
- D. Blended Hydraulic Cement: ASTM C595/C595M, Type IL, Portland-limestone cement.
- E. Normal-Weight Aggregates: ASTM C 33, Class 4S 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 inch
 2. For exposed exterior surfaces, do not use fine or coarse aggregates that contain substances that cause spalling.
 3. Provide aggregates free of materials with deleterious reactivity to alkali in cement, to prevent damage due to concrete expansion from alkali silicate and alkali carbonate reactions.
- F. Water: ASTM C 94, potable.
- G. Admixtures, General: Provide 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.
- H. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
- I. Water-Reducing Admixture: ASTM C 494, Type A.
- J. High-Range Water-Reducing Admixture: ASTM C 494, Type F.
- K. High-Range Water-Reducing and Retarding Admixture: ASTM C 494, Type G
- L. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
- M. Retarding Admixture: ASTM C 494, Type B.

2.5 WATERSTOPS

- A. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer-modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch.
 - 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. Adeka Ultra Seal/OCM, Inc.
 - b. CETCO, a Minerals Technologies company.
 - c. Grace Construction Products; W.R. Grace & Co. -- Conn.

2.6 VAPOR RETARDERS

- A. Sheet Vapor Retarder: ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
 - a. Fortifiber Corporation; Moistop Ultra A.
 - b. Raven Industries Inc.; Vapor Block 15.
 - c. Reef Industries, Inc.; Griffolyn Type-65G.
- B. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 448, Size 57, with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

2.7 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work, include, but are not limited to, the following:
 - a. Axim Italcementi Group, Inc.; CATEXOL CimFilm.
 - b. BASF Construction Chemicals - Building Systems; Confilm.
 - c. ChemMasters; SprayFilm.
 - d. Conspec by Dayton Superior; Aquafilm.
 - e. Dayton Superior Corporation; Sure Film (J-74).
 - f. Edoco by Dayton Superior; BurkeFilm.
 - g. Euclid Chemical Company (The), an RPM company; Eucobar.
 - h. Kaufman Products, Inc.; Vapor-Aid.
 - i. Lambert Corporation; LAMBCO Skin.
 - j. L&M Construction Chemicals, Inc.; E-CON.

- k. Meadows, W. R., Inc.; EVAPRE.
 - l. Metalcrete Industries; Waterhold.
 - m. Nox-Crete Products Group; MONOFILM.
 - n. Sika Corporation; SikaFilm.
 - o. SpecChem, LLC; Spec Film.
 - p. Symons by Dayton Superior; Finishing Aid.
 - q. TK Products, Division of Sierra Corporation; TK-2120 TRI-FILM.
 - r. Unitex; PRO-FILM.
 - s. Vexcon Chemicals, Inc.; Certi-Vex Envio Set.
- B. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry, complying with AASHTO M 182, Class 2.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

2.8 RELATED MATERIALS

- A. Dovetail Anchor Slots: Hot-dip galvanized sheet steel, not less than 0.034 inch thick with bent tab anchors. Fill slot with temporary filler or cover face opening to prevent intrusion of concrete or debris.
- B. Bonding Agent: ASTM C 1059, Type II, nonredispersible, acrylic emulsion or styrene butadiene.
- C. Concrete Sealer:
- 1. Solvent based, clear, breathable, high-performance, 100 percent silane, penetrating water repellent sealer for protecting concrete surfaces.
 - 2. Sealer shall protect concrete against water, chloride ion and acid penetration and against freeze/thaw cycles.
 - 3. Sealer shall have a minimum average penetration depth of 0.35 inch and shall not change the surface appearance of the concrete after application.
 - 4. Subject to compliance with requirements, products that may be incorporated in the Work include the following:
 - a. MasterProtect H 1000, by Master Builders Solutions by BASF.
 - b. An equivalent approved by the Engineer.

2.9 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. For the trial batch

method, use an independent testing agency acceptable to Engineer for preparing and reporting proposed mix designs.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
 2. Do not use the same testing agency for field quality control testing.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as follows:
1. Fly Ash: 25 percent.
 2. Slag Cement: 50 percent.
- C. Submit written reports to Engineer of each proposed design mixture for each class of concrete at least 15 days prior to start of Work. Do not begin concrete production until proposed design mixtures have been approved by Engineer.
- D. Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) in concrete, as required, for placement and workability.
 2. Use accelerating admixture in concrete slabs placed at ambient temperatures below 50 deg F.
 3. Use high-range water-reducing admixture in pumped concrete or concrete with water-cement ratios below 0.50.
 4. Use air-entraining admixture in all concrete unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content of 6.0 percent plus or minus 1-1/2 percent for all concrete except footings, which shall have a total air content of 3.0 percent plus or minus 1-1/2 percent.
 5. Use admixtures for water reduction and set accelerating or retarding in strict compliance with manufacturer's directions.
- E. Design mixtures to provide normal weight concrete with the following properties as indicated on drawings and schedules:
1. 5,000 psi, 28-day compressive strength; water-cement ratio, 0.40 maximum.
- F. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:
1. Slabs, and sloping surfaces: Not more than 3 inches.
 2. Reinforced foundation systems: Not less than 1 inch and not more than 3 inches.
 3. Concrete containing high-range water-reducing admixture (superplasticizer): Not more than 8 inches after adding admixture to verified 2 - 3 inch slump concrete.
 4. Other concrete: Not more than 4 inches.
- G. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, as accepted by Engineer. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Engineer before using in Work.

2.10 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94, and as specified, and furnish batch ticket information.
 - 1. When air temperature is between 85 deg F and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 GENERAL

- A. Coordinate the installation of joint materials and other related materials with placement of forms and reinforcing steel.
- B. Tolerances: Tolerances for Concrete Construction and Materials shall conform to all requirements of ACI 117, Standard Specifications for Tolerances for Concrete Construction and Materials.

3.2 FORMWORK INSTALLATION

- A. General: Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, plus construction loads that might be applied, until concrete structure can support such loads.
- B. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
 - 1. Class A, 1/8 inch for smooth-formed finished concrete surfaces exposed to view.
 - 2. Class B, 1/4 inch for other-formed finished concrete surfaces not exposed to view.
- D. Construct forms to sizes, shapes, lines, and dimensions shown and to obtain accurate alignment, location, grades, level, and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, chamfers, blocking, bulkheads, anchorages and inserts, and other features required in the Work. Use selected materials to obtain required finishes.
- E. Construct forms tight enough to prevent loss of concrete mortar.
- F. Construct forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates 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, recesses, and the like for easy removal.

2. Do not use rust-stained steel form-facing material.

- G. 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.
- H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible before and during concrete placement. 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.
- I. Chamfer exposed corners and edges of permanently exposed concrete as indicated, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.
- J. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.
- K. Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- L. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- M. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.3 EMBEDDED ITEM 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.
- B. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
- C. Install dovetail anchor slots in concrete structures as indicated on drawings.

3.4 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of 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 24 hours after placing concrete. Concrete shall be hard enough to not be damaged by form-removal operations, and curing and protection operations shall be maintained.
 - 1. Leave formwork for beam soffits, slabs, and other structural elements that support weight of concrete in place until concrete has achieved at least 75 percent of the 28-day design

- minimum compressive strength. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members.
2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

- 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 Engineer.

3.5 SHORING AND RESHORING INSTALLATION

- A. General: Comply with ACI 318 and ACI 301 for design, installation and removal of shoring and reshoring in multistory construction, and as specified.
- B. In multistory construction, extend shoring or reshoring from ground to roof, unless otherwise permitted by Engineer, to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.
- C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.
- D. Keep reshores in place a minimum of 15 days after placing upper tier, or longer, if required, until all concrete has attained at least 75 percent of its required 28-day strength and heavy loads due to construction operations have been removed.

3.6 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.

3.7 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 or destroy bond with concrete.

- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with metal chairs, runners, bolsters, spacers, and hangers, as approved by the Engineer. Do not tack weld crossing reinforcing bars.
- D. Place reinforcement to maintain minimum coverages as indicated for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are 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 full mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.8 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 Engineer.
- C. Provide keyways at least 1-1/2 inches deep in construction joints between stair slabs and supporting slabs. Bulkheads designed and accepted for this purpose may be used for slabs.
- D. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints except as indicated otherwise. Do not continue reinforcement through sides of strip placements.
- E. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- F. Joint fillers: Prepare surfaces and install joint fillers in accordance with the requirements of the manufacturer. Provide non-staining sealants with 1-year warranty and as follows:
 - 1. Isolation Joint between concrete slabs and concrete faces, where indicated on drawings: Fill joint with standard chemically curing elastomeric sealants that comply with ASTM C 920, Grade P, Class 25, Use T, with additional movement capability of 50 percent movement in extension and 50 percent movement in compression for a total of 100 percent movement. Subject to compliance with requirements, products that may be incorporated in the Work include the following:
 - a. Sikaflex 1C SL; Sika USA
 - b. Tremco Vulkem 116; Tremco CPG
 - c. Masterseal SL1; BASF
 - 2. Isolation Joint between concrete slabs and masonry faces, where indicated on drawings: Fill joint with standard chemically curing elastomeric sealants that comply with ASTM C 920, Grade NS, Class 25, Use T, with additional movement capability of 50 percent movement in extension and 50 percent movement in compression for a total of 100 percent movement. Subject to compliance with requirements, products that may be incorporated in the Work include the following:
 - a. Sikaflex 1A; Sika USA

- b. Tremco Dymonic 100; Tremco CPG
 - c. Masterseal NP1; BASF
- G. Contraction (Control) Joints in Slabs-on-Grade: Construct contraction joints in slabs-on-grade to form panels of patterns as shown on the Drawings. Provide contraction joints that meet either of the following requirements:
 - 1. Inserts: Form contraction joints by inserting premolded plastic, hardboard, or fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. Inserts shall be 1/4 inch wide by one-fourth of slab depth. Tool slab edges round on each side of insert. After concrete has cured, remove inserts and clean groove of loose debris.
 - 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8 inch joints into the top of the concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

3.9 WATERSTOP INSTALLATION

- 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.

3.10 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed. Notify other trades to permit installation of their work.
- B. Do not add water to concrete during delivery, at Project site, or during placement, except as follows. Water withheld at the batch plant may be added at the Project site, provided that the amount withheld is noted on the batch ticket, the water added does not exceed the amount withheld and is documented by the testing agency, and the concrete is properly mixed prior to sampling, testing, and placement.
 - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- C. General: Comply with ACI 304, "Guide for Measuring, Mixing, Transporting, and Placing Concrete," and as specified.
- D. Provide monolithic slabs without joints, holes, penetrations, or embedded items that pass through the entire thickness, unless shown on the drawings, to prevent moisture from passing through the slab into the thermal lining system below, which could void the thermal lining warranty and cause safety and durability issues. For floor and roof slabs, do not support anything on the bottom forms other than reinforcing chairs and bolsters. Do not have any item pass through the entire slab thickness, including snap-ties or items used to support screeds or forms at tops of slabs, unless shown on the drawings. Support any items used to support screeds or forms at tops of slabs from the reinforcing mats, not the bottom forms.

- E. 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 specified. Deposit concrete to avoid segregation at its final location.
- F. Placing Concrete in Formwork: Deposit concrete in formwork in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.
 - 1. Consolidate placed concrete with mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping according to ACI 301.
 - 2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the machine. Place vibrators 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.
- G. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until completing placement of a panel or section.
 - 1. Consolidate concrete during placement operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 - 2. Maintain reinforcement in proper position on chairs during concrete placement.
 - 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 - 4. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane free of humps or hollows, before excess bleedwater appears on the surface. Do not further disturb slab surfaces prior to beginning finishing operations.
 - 5. Slope surfaces uniformly to drainage openings (scuppers and doorways) as indicated on the drawings.
 - 6. When placing concrete on sloping formwork at concrete stairs, begin placing concrete at lowest elevation of formwork and work up toward the highest elevation.

3.11 FINISHING FORMED SURFACES

- A. 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 defective areas. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Provide concrete with formed Concrete Surface Categories (CSCs), as defined by ACI 347.3R "Guide to Formed Concrete Surfaces", as follows:
 - a. CSC 3: Concrete surfaces of all concrete walls, parapets, columns, and exterior beams.
 - b. CSC 2: Concrete surfaces at bottoms of concrete slabs and at bottoms and sides of interior concrete beams.

3.12 FINISHING SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Float Finish: Apply float finish to monolithic slab surfaces to receive broom finish, pavement finish and elsewhere as indicated.
 - 1. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. 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 restraighening until surface is left with a uniform, smooth, granular texture.
- B. Nonslip Broom Finish: Apply a nonslip broom finish to concrete roofs, elevated slabs, slab-on-grade, steps, landings, and other locations indicated.
 - 1. Immediately after float finishing, slightly roughen trafficked concrete surface by brooming with fiber-bristle broom perpendicular to main traffic route.

3.13 MISCELLANEOUS CONCRETE ITEM INSTALLATION

- 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. Curbs: Provide monolithic finish to curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

3.14 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 301 for hot-weather protection during curing.
- 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. 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 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.
 - 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.

3.15 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.
- B. Patching mortar: Mix dry-pack patching mortar, consisting of one part portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing.
- C. Repairing Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Engineer. 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, voids over 1/4 inch in any dimension, and holes left by tie rods and bolts down to solid concrete but in no case to a depth less than 1 inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie holes or voids with patching mortar or precast cement 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 matches 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, where possible, that affect the concrete's durability and structural performance as determined by Engineer. If defects cannot be repaired, remove and replace the concrete.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for finish and verify surface tolerances specified for each surface and finish. Correct low and high areas as specified. Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having the required slope.
1. Repair finished unformed surfaces containing defects that affect the concrete's durability. Surface defects include crazing and cracks in excess of 0.01 inch wide or that penetrate to the reinforcement or completely through unreinforced sections regardless of width, spalls, popouts, honeycombs, rock pockets, and other objectionable conditions.
 2. Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.
 3. Correct localized low areas in unformed surfaces 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. Repair defective areas, except random cracks and single holes not exceeding 1 inch in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least 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.
 5. Unless otherwise directed to epoxy inject, 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.

3.16 CONCRETE SEALER

- A. Apply concrete sealer to top surfaces of concrete slabs where indicated in drawings.
- B. After concrete has cured minimum 28 days, clean and prepare concrete surfaces in accordance with the manufacturer's requirements. Remove dust, dirt, oil, grease, chemical films, coatings and other contaminants before application. Do not apply sealer if standing water is visible on surface to be treated.
- C. Apply sealer evenly distributed with flooding action, eliminating ponding.
- D. Protect sealer from damage during construction.

3.17 FIELD QUALITY CONTROL AND TESTING DURING CONSTRUCTION

- A. General: The Owner will employ a qualified testing and inspection agency to perform field tests and inspections and to submit test/inspection reports.
- B. Inspections:
 - 1. Steel reinforcement placement: visual inspection of all steel reinforcing, prior to all concrete pours, including, but not limited to, the following:
 - a. Reinforcing sizes.
 - b. Reinforcing spacing.
 - c. Lap and splice lengths.
 - d. Bends and hooks.
 - e. Minimum cover.
 - f. Maximum cover.
 - g. Chairs, bolsters, and other support devices.
 - h. Wire ties at all intersections between bars and between bars and supports.
- C. Sampling and testing for quality control during concrete placement includes the following, as directed by the Engineer.
 - 1. Sampling Fresh Concrete: 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 one composite sample for each day's pour of each concrete mixture exceeding 2 cubic yards, but less than 25 cubic yards, plus one set for each additional 50 cubic yards or fraction thereof.
 - b. Slump: ASTM C 143; 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; one test for each composite sample, but not less than one test for each day's pour of each air-entrained concrete mixture.
 - d. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below, when 80 deg F and above, and one test for each composite sample.
 - e. Compression Test Specimens: ASTM C 31; Cast and cure sets of standard cylinders for each composite sample for each compressive-strength test described below, unless otherwise directed.
 - f. Compressive-Strength Tests: ASTM C 39; one set of four standard cylinders for laboratory-cured testing and one set of four standard cylinders for field-cured testing for each composite sample. One laboratory-cured specimen tested at 7 days, two laboratory-cured specimens tested at 28 days, and one laboratory-cured specimen held in reserve for later testing if required. One field-cured specimen tested at 7 days, two field-cured specimens tested at 28 days, and one field-cured specimen tested at a time desired by the Contractor for determining if the concrete has reached sufficient strength to remove formwork and/or shoring.

2. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
 3. Strength of each concrete mixture will be considered satisfactory if every average of any three consecutive compressive-strength test results equals or exceeds specified compressive strength and no individual compressive-strength test value falls below specified compressive strength by more than 500 psi.
- D. Test and inspection results will be reported in writing to Engineer, ready-mix producer, and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the Project identification name and number, date of concrete placement, name of concrete testing and inspection agency, location of concrete batch in structure, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.
- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but shall not be used as the sole basis for approval or rejection of concrete.
- F. Additional Tests: The testing and inspecting agency shall make additional tests of in-place concrete when test results indicate that specified concrete compressive strengths, slump, air-entrainment, and other requirements have not been met in the structure, as directed by Engineer. 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 Engineer.
- G. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- H. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

END OF SECTION 03 30 00.01

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. Mortar and grout materials.
3. Steel reinforcing bars.
4. Ties and anchors.
5. Embedded flashing.
6. Accessories.

B. Products Installed but not Furnished under This Section:

1. Steel lintels in unit masonry.
2. Steel shelf angles for supporting unit masonry.

C. Related Requirements:

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 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For the following:
 1. Masonry Units: Indicate sizes, profiles, coursing, and locations of special shapes.

2. Reinforcing Steel: Indicate bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315R. Indicate elevations of reinforced walls.
 3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
- C. Samples for Initial Selection:
1. Concrete face brick, in the form of small-scale units.
 2. Colored mortar.
 3. Weep/cavity vents.
- D. Samples for Verification: For each type and color of the following:
1. Exposed CMUs.
 2. Special brick shapes.
 3. Pigmented mortar. Make Samples using same sand and mortar ingredients to be used on Project.
 4. Weep/cavity vents.
 5. Accessories embedded in masonry.

INFORMATIONAL SUBMITTALS

- E. Material Certificates: For each type of the following:
1. Masonry units.
 - a. Include data on material properties.
 2. Integral water repellent used in CMUs.
 3. Cementitious materials. Include name of manufacturer, brand name, and type.
 4. Mortar admixtures.
 5. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
 6. Grout mixes. Include description of type and proportions of ingredients.
 7. Reinforcing bars.
 8. Joint reinforcement.
 9. Anchors, ties, and metal accessories.
- F. Qualification Statements: For testing agency.
- G. 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 in accordance with ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
 2. Include test reports, in accordance with ASTM C1019, for grout mixes required to comply with compressive strength requirement.
- H. 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 in accordance with TMS 602.

- I. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.5 QUALITY ASSURANCE

- A. Qualifications:
- B. Testing Agency Qualifications: Qualified in accordance with ASTM C1093 for testing indicated.
- C. 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.
- D. 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.
- E. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.
- F. 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. Clean one-half of exposed faces of panels with masonry cleaner indicated.
 3. Protect approved sample panels from the elements with weather-resistant membrane.
 4. 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.

1.6 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. Store preblended, dry mortar mix in delivery containers on elevated platforms 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.

1.7 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 (610 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 (610 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 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 TMS 602.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain exposed masonry units, cementitious mortar components, and mortar aggregate from single manufacturer.
- B. For exposed masonry units and cementitious mortar components, obtain each color and grade from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.2 UNIT MASONRY, GENERAL

- A. Masonry Standard: Comply with TMS 602, except as modified by requirements in the Contract Documents.
- B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work and will be within 20 ft. vertically and horizontally of a walking surface.
- C. Standard Units: Provide standard units of nominal sizes. When selecting special shapes, such as bullnose, bond/lintels, check for availability. If selected bond/lintel not available during construction phase of project, alert Architect immediately. Architect to provide alternate structural detail using available concrete masonry units/grout fill/steel rebars.

2.3 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 square-edged 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 according to ASTM E 514/E 514M as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, shall 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) BASF Corporation.
 - 3) Euclid Chemical Company (The); an RPM company.
 - 4) GCP Applied Technologies Inc.
 - 5) Moxie International.

- C. CMUs: ASTM C90
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
 4. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.
 5. Corners: Provide cornerblocks or bullnose shapes at exposed CMU corners.
- D. Concrete Masonry Units: ASTM C1634, normal weight.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Echelon; Shot-blasted Mesastone or a comparable product by one of the following:
 - a. CemexUSA
 - b. Nitterhouse Masonry
 2. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3500 psi net area average of 3 units, when tested in accordance with ASTM C1634.
 3. Freeze-thaw durability: Meets or exceeds the requirements of ASTM C1262-98 and exhibit a mass loss no greater than 1.5%. Test specimens must not show any fracture completely through the cross section when subjected to 50 consecutive freeze/thaw cycles.
 4. Integral Water Repellant: Concrete Masonry Units must include a water repellant admixture at the time of production.
 5. Maximum absorption range by weight: 10 lbs./cu. Ft. average of 3 units, individual unit maximum absorption 12 lbs/cu ft (based on normal weight).
 6. Minimum weight: 125 lbs/cu ft.
 7. Size (Nominal Dimensions): 4 inches wide by 2-1/4 inches high by 16 inches long.
 8. Texture: Shot-blasted.
 9. Type: Shall be tested and rated "not effloresced" and rated for Severe Weathering (SW), Type FBX.
 10. Colors: As selected by Architect from manufacturer's full range.
 - a. Basis of Design: Echelon; Shot-blasted Mesastone
 - 1) Color: 4106 Charcoal, Group 1

2.4 LINTELS

- A. Concrete Lintels: Precast or formed-in-place concrete lintels complying with requirements in Section 032000 "Concrete Reinforcing," and with reinforcing bars indicated.
- B. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.
- C. Offset Angle Supports: Steel plate brackets anchored to structure, allowing continuous insulation behind shelf angle supporting veneer. Component and anchor size and spacing engineered by manufacturer.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. FERO Corporation.
 - b. Halfen USA, Inc.
 - c. Hohmann & Barnard, Inc.
2. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304.
3. Carbon Steel: Galvanized after Fabrication.

2.5 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C150/C150M, 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 C207, Type S.
- C. Masonry Cement: ASTM C91/C91M.
- D. 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 masonry mortar.
- E. Aggregate for Mortar: ASTM C144.
 1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
 2. For joints less than 1/4 inch (6.4 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.
 3. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- F. Aggregate for Grout: ASTM C404.
- G. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent from same manufacturer. Type S with liquid water-repellent mortar admixture intended for use with concrete masonry units containing water-repellent from same manufacturer. Provide colored mortar as selected by Architect.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ACM Chemistries.
 - b. Euclid Chemical Company (The); an RPM company.
 - c. GCP Applied Technologies Inc.
 - d. Master Builders Solutions.
- H. Water: Potable.

2.6 REINFORCEMENT

- A. Uncoated-Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, Grade 60.
- B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from 0.148-inch (3.77-mm) carbon steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated. Lap reinforcement a minimum of 6 inches.
- C. Masonry-Joint Reinforcement, General: ASTM A951/A951M.
 - 1. Interior Walls: Hot-dip 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 (406 mm) o.c.
 - 7. Provide in lengths of not less than 10 ft. (3 m), with prefabricated corner and tee units.
- D. Masonry-Joint Reinforcement for Single-Wythe Masonry: Ladder type with single pair of side rods.

2.7 TIES AND ANCHORS

- A. General: Ties and anchors shall extend at least 1-1/2 inches (38 mm) into veneer but with at least a 5/8-inch (16-mm) cover on outside face.
- B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:
 - 1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A1064/A1064M, with ASTM A153/A153M, Class B-2 coating.
 - 2. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- C. 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- (6.4-mm-) diameter, hot-dip galvanized steel wire.
 - 2. Tie Section: Triangular-shaped wire tie made from 0.25-inch- (6.4-mm-) diameter, hot-dip galvanized steel wire.
- D. 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.
- E. Partition Top Anchors: 0.105-inch- (2.66-mm-) thick metal plate with a 3/8-inch- (10-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.

2.8 EMBEDDED FLASHING

- A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:
1. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, 0.016 inch (0.40 mm) thick.
 2. Fabricate continuous flashings in sections 96 inches (2438 mm) long minimum, but not exceeding 12 ft. (3.7 m). Provide splice plates at joints of formed, smooth metal flashing.
 3. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
 4. 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.
 5. Fabricate metal drip edges 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.
 6. Fabricate metal expansion-joint strips from stainless steel to shapes indicated.
 7. Solder metal items at corners.
- B. Flexible Flashing: Use the following unless otherwise indicated:
1. Self-Adhering, Stainless Steel Fabric Flashing: Composite, flashing product consisting of 2 mil (0.05 mm) of Type 304 stainless steel sheet, bonded to a layer of polymeric fabric with a permanent, clear adhesive, to produce an overall thickness of 10 mil.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hohmann & Barnard, Inc.
 - 2) STS Coatings, Inc.
 - 3) York Manufacturing, Inc.
 - b. Applications: Use 10-mil- (0.25-mm-) thick flashing at windows, doors, and small wall penetrations; not at base of walls. Use 40-mil- (1.0-mm-) thick flashing at base of walls.
- C. Solder and Sealants for Sheet Metal Flashings: As specified in Section 076200 "Sheet Metal Flashing and Trim."
1. Solder for Stainless Steel: ASTM B32, Grade Sn96, with acid flux of type recommended by stainless steel sheet manufacturer.
 2. Elastomeric Sealant: ASTM C920, chemically curing urethane sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and remain watertight.
- 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.

- E. Termination Bars for Flexible Flashing, Flanged: Stainless steel sheet 0.019 inch by 1-1/2 inches (0.48 mm by 38 mm) with a 3/8-inch (10-mm) sealant flange at top.
- F. 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.

2.9 ACCESSORIES

- A. Compressible Filler: Pre-molded filler strips complying with ASTM D1056, 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 D2000, Designation M2AA-805 or PVC, complying with ASTM D2287, 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 felt complying with ASTM D226/D226M, Type I (No. 15 asphalt felt).
- D. Weep/Cavity Vents: Use one of the following unless otherwise indicated:
 - 1. Rectangular Plastic Weep/Vent Tubing: Clear butyrate, 3/8 by 1-1/2 by 3-1/2 inches long.
 - 2. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch (3.2 mm) less than depth of outer wythe, in color selected from manufacturer's standard.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Advanced Building Products Inc.
 - 2) Heckmann Building Products, Inc.
 - 3) Hohmann & Barnard, Inc.
 - 4) Wire-Bond.
- E. Proprietary Acidic Masonry 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.

2.10 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 mortar unless otherwise indicated.
 3. For exterior masonry, use portland cement-lime mortar.
 4. For reinforced masonry, use portland cement-lime mortar.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended 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 C270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated.
1. For masonry below grade or in contact with earth, use Type M.
 2. For reinforced masonry, use Type S.
 3. For mortar parge coats, use Type S or Type N.
 4. For exterior, above-grade, load-bearing, 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. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
1. Mix to match Architect's sample.
 2. Application: Use colored-aggregate mortar for exposed mortar joints with the following units: Concrete face brick and any associated special shapes.
- E. Grout for Unit Masonry: Comply with ASTM C476.
1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602 for dimensions of grout spaces and pour height.
 2. Proportion grout in accordance with ASTM C476, Table 1 or paragraph 4.2.1.2 for specified 28-day compressive strength indicated, but not less than 2000 psi.
 3. Provide grout with a slump of 8 to 11 inches as measured in accordance with ASTM C143/C143M.

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 the Work.
 2. Verify that foundations are within tolerances specified.
 3. Verify that reinforcing dowels are properly placed.
 4. Verify that substrates are free of substances that impair mortar bond.

- 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 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. 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. per minute when tested in accordance with ASTM C67/C67M. 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 or minus 1/4 inch.
 - 2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.
 - 3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch 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 ft., or 1/2-inch 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 ft., 1/4 inch in 20 ft., or 1/2-inch maximum.
 - 3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 ft., 3/8 inch in 20 ft., or 1/2-inch 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 ft., 1/4 inch in 20 ft., or 1/2-inch maximum.
5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 ft., 3/8 inch in 20 ft., or 1/2-inch maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 ft., or 1/2-inch maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch 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, with a maximum thickness limited to 1/2 inch.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch 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 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 4 inches. Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.
- D. Stopping and Resuming Work: Stop work by stepping 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 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 clearance between end of anchor rod and end of tube. Space anchors 24 inches o.c. unless otherwise indicated.
 - 3. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078443 "Joint Firestopping."

3.5 MORTAR BEDDING AND JOINTING

- A. Lay CMUs as follows:
 - 1. Bed face shells in mortar and make head joints of depth equal to bed joints.
 - 2. Bed webs in mortar in all courses of piers, columns, and pilasters.
 - 3. Bed webs in mortar in grouted masonry, including starting course on footings.
 - 4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
 - 5. Fully bed units and fill cells with mortar at anchors and ties as needed to fully embed anchors and ties in mortar.
- 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. Set trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.
 - 1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
 - 2. Allow cleaned surfaces to dry before setting.
 - 3. Wet joint surfaces thoroughly before applying mortar.
 - 4. Rake out mortar joints for pointing with sealant.
- D. Tool exposed joints:
 - 1. CMU: Slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
 - 2. Concrete Face Brick: Tool exposed horizontal joints continuous with struck weathered joint and flush vertical joints to accentuate horizontal lines.
- E. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

- F. Cut joints flush where indicated to receive waterproofing, cavity wall insulation, and air barriers unless otherwise indicated.

3.6 COMPOSITE MASONRY

- A. Bond wythes of composite masonry together using one of the following methods:
 - 1. Individual Metal Ties: Provide ties as indicated installed in horizontal joints, but not less than one metal tie for 2.67 sq. ft. of wall area spaced not to exceed 24 inches o.c. horizontally and 16 inches o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches of openings and space not more than 36 inches apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches o.c. vertically.
 - a. Where bed joints of wythes do not align, use adjustable-type (two-piece-type) ties.
 - 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-type (two-piece-type) reinforcement.
 - 3. Header Bonding: Provide masonry unit headers extending not less than 3 inches into each wythe. Space headers not more than 8 inches clear horizontally and 16 inches clear vertically.
- B. Bond wythes of composite masonry together using bonding system indicated on Drawings.
- C. Corners: Provide interlocking masonry unit bond in each wythe and course at corners unless otherwise indicated.
 - 1. Provide continuity with masonry-joint reinforcement at corners by using prefabricated L-shaped units as well as masonry bonding.
- D. Intersecting and Abutting Walls: Unless vertical expansion or control joints are indicated at juncture, bond walls together as follows:
 - 1. Provide individual metal ties not more than 16 inches o.c.
 - 2. Provide continuity with masonry-joint reinforcement by using prefabricated T-shaped units.
 - 3. Provide rigid metal anchors not more than 24 inches o.c. If used with hollow masonry units, embed ends in mortar-filled cores.

3.7 MASONRY-JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

1. Space reinforcement not more than 16 inches o.c.
 2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
 3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches 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 2 inches 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 o.c. vertically and 36 inches o.c. horizontally.

3.9 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 as follows:
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. Provide horizontal, pressure-relieving joints by either leaving an airspace or inserting a compressible filler of width required for installing sealant and backer rod specified in Section 079200 "Joint Sealants," but not less than 3/8 inch.
1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.10 LINTELS

- A. Install steel lintels where indicated.
- B. Provide concrete, masonry, or offset angle support lintels where indicated and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are indicated without structural steel or other supporting lintels.
- C. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.11 FLASHING, WEEP HOLES, AND CAVITY 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 cavity 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 masonry-veneer walls, extend flashing through veneer, across airspace behind veneer, and up face of sheathing at least 8 inches; with upper edge tucked under water-resistive barrier, lapping at least 4 inches. Fasten upper edge of flexible flashing to sheathing through termination bar.
 - 3. At lintels and shelf angles, extend flashing 6 inches minimum at each end. At heads and sills, extend flashing 6 inches minimum and turn ends up not less than 2 inches to form end dams.
 - 4. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing **1/2 inch (13 mm)** back from outside face of wall, and adhere flexible flashing to top of metal drip edge.
- 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 indicated to be built into masonry.
- E. Install weep holes in exterior wythes and veneers in head joints of first course of masonry immediately above embedded flashing.
 - 1. Space weep holes formed from plastic tubing **16 inches (406 mm)** o.c.
- F. Place cavity drainage material in airspace behind veneers to comply with configuration requirements for cavity drainage material in "Accessories" Article.

- G. Install cavity vents in head joints in exterior wythes at spacing indicated. Use specified weep/cavity vent products to form cavity vents.
 - 1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.12 REINFORCED UNIT MASONRY

- 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 that of other loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in 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 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.

3.13 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements will be at Contractor's expense.
- B. Inspections: Special inspections in accordance with Level 2 in TMS 402.
 - 1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
 - 2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
 - 3. Place grout only after inspectors have verified proportions of site-prepared grout.
- C. Testing Prior to Construction: One set of tests.
- D. Concrete Masonry Unit Test: For each type of unit provided, in accordance with ASTM C140/C140M for compressive strength.

- E. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, in accordance with ASTM C780.
- F. Mortar Test (Property Specification): For each mix provided, in accordance with ASTM C780. Test mortar for mortar air content and compressive strength.
- G. Grout Test (Compressive Strength): For each mix provided, in accordance with ASTM C1019.
- H. Prism Test: For each type of construction provided, in accordance with ASTM C1314 at 7 days and at 28 days.

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. Protect adjacent stone and non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
 - 4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
 - 5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
 - 6. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.
 - 7. Clean masonry with a proprietary acidic masonry cleaner applied according to manufacturer's written instructions.

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.

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- B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
1. Crush masonry waste to less than 4 inches in each dimension.
 2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Section 312000 "Earth Moving."
 3. Do not dispose of masonry waste as fill within 18 inches of finished grade.
- C. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.
- D. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042000

SECTION 04 20 00.01 - UNIT MASONRY ASSEMBLIES - BURN BUILDING AND TRAINING TOWER

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. Concrete unit masonry.
2. Fire brick.
3. Precast concrete lintels, including refractory concrete lintels.
4. Masonry Lintels
5. Mortar and grout.
6. Steel reinforcing bars.
7. Masonry joint reinforcement.
8. Ties and anchors.
10. Miscellaneous masonry accessories.
12. Masonry Cleaners.
13. Mortar and grout mixes.
14. Integral water repellant for masonry units and mortar.
15. Masonry sealers.
16. Cast-in-place masonry wall caps.

- B. Products furnished but not installed under this Section include the following:

1. Dovetail slots for masonry anchors installed under Division 03 Section "Cast-in-Place Concrete."

1.3 PERFORMANCE REQUIREMENTS

- A. Provide unit masonry that develops installed compressive strengths (f_m) at 28 days, based on net area, of 2,000 psi.
 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.

1.4 SUBMITTALS

- A. General: Submit each item in this Article according to the General Conditions of the Contract and Division 01 Specification Sections.
- B. Product data and material certifications for each different masonry unit, accessory, and other manufactured product specified.

1.5 QUALITY ASSURANCE

- A. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Division 01 Section "Project Management and Coordination".
- 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. Sample Panels: Build sample panels to verify selections made under sample submittals and to demonstrate aesthetic effects. Comply with requirements in Division 01 Section "Quality Requirements" for mockups.
 - 1. Build sample panels for typical exterior wall in sizes approximately 144 inches long by 144 inches high by full thickness.
 - 2. Clean exposed faces of panels with masonry cleaner indicated.
 - 3. Protect approved sample panels from the elements with weather-resistant membrane.
 - 4. Approval of sample panels shall be 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/Engineer in writing.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion, and other causes. 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 in an air-dried condition.
- 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.
- F. Store masonry cleaners and water repellent coatings in unopened original containers, in a cool, dry location away from possible ignition sources and in accordance with the manufacturer's recommendations.

1.7 PROJECT CONDITIONS

- A. Protection of Masonry: During erection, 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.
- B. 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 mortar splatter by coverings spread 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 on completed masonry.
- C. Cold-Weather Requirements: 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 masonry damaged by frost or freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1 and as follows:
 - 1. Cold-Weather Construction: When the ambient temperature is within the limits indicated, use the following procedures:
 - a. 40 to 32 deg F: Heat mixing water or sand to produce mortar temperatures between 40 and 120 deg F.
 - b. 32 to 25 deg F: Heat mixing water and sand to produce mortar temperatures between 40 and 120 deg F. Heat grout materials to produce grout temperatures between 40 and 120 deg F. Maintain mortar and grout above freezing until used in masonry.
 - c. 25 to 20 deg F: Heat mixing water and sand to produce mortar temperatures between 40 and 120 deg F. Heat grout materials to produce grout temperatures between 40 and 120 deg F. Maintain mortar and grout above freezing until used in masonry. Heat masonry units to 40 deg F if grouting. Use heat on both sides of walls under construction.

- d. 20 deg F and Below: Heat mixing water and sand to produce mortar temperatures between 40 and 120 deg F. Heat grout materials to produce grout temperatures between 40 and 120 deg F. Maintain mortar and grout above freezing until used in masonry. Heat masonry units to 40 deg F. Provide enclosures and use heat on both sides of walls under construction to maintain temperatures above 32 deg F within the enclosures.
2. Cold-Weather Protection: When the mean daily temperature is within the limits indicated, provide the following protection:
 - a. 40 to 25 deg F: Cover masonry with a weather-resistant membrane for 48 hours after construction.
 - b. 25 to 20 deg F: Cover masonry with insulating blankets or provide enclosure and heat for 48 hours after construction to prevent freezing. Install wind breaks when wind velocity exceeds 15 mph.
 - c. 20 deg F and Below: Provide enclosure and heat to maintain temperatures above 32 deg F within the enclosure for 48 hours after construction.
3. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until masonry has dried out, but not less than 7 days after completion of cleaning.
- D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1.

PART 2 - PRODUCTS

2.1 CONCRETE MASONRY UNITS

- A. General: Provide shapes indicated and as follows for each form of concrete masonry unit required, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
 1. Provide special shapes for lintels, corners, jambs, control joints, headers, bonding, and other special conditions.
 2. Provide bullnose units for outside corners of all interior walls, jambs at openings, and where indicated on the drawings.
 3. Provide finished, square-edged units for outside exterior corners, unless otherwise indicated.
- B. Integral Water Repellent: Provide units made with integral water repellent for all masonry.
 1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength.
 2. Units made with integral water repellent, when tested according to ASTM E 514 as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 72 hours, shall achieve a rating of Excellent (top possible rating) with 0% dampness on the back of test specimen.

- a. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include the following:
 - 1) ACM Chemistries; RainBloc 80.
 - 2) Cargill, Inc., Acme Shield.
 - 3) Euclid Chemical Company; Eucon Blocktite.
 - 4) Euclid Chemical Company; Eucon Hydrapel 2.0.
 - 5) GCP Applied Technologies, Inc.; Dry-Block Block Admixture.
 - 6) Master Builders; MasterPel 240.
 2. Add water repellent admixture to units as recommended by water repellent manufacturer to achieve maximum water repellency in addition to efflorescence control.
- C. Concrete Masonry Units: ASTM C 90 and as follows:
1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2,000 psi.
 2. Density Classification: Normal weight, as indicated on the drawings.
 3. Aggregates: Complying with ASTM C-33 for normal weight aggregate.
 4. Size: Manufactured to the actual dimensions listed below (within tolerances specified in the applicable referenced ASTM specification) for the corresponding nominal sizes indicated on Drawings:
 - a. 4 inch nominal: 3-5/8 inch actual.
 - b. 6 inch nominal: 5-5/8 inch actual.
 - c. 8 inch nominal: 7-5/8 inch actual.
 - d. 12 inch nominal: 11-5/8 inch actual.
 - e. 16 inch nominal: 15-5/8 inch actual.
 5. Manufacturer's standard color (gray) and texture (standard smooth face finish), unless otherwise indicated.

2.2 FIRE BRICK

- A. General: Provide shapes indicated and as follows. Provide units without cores or frogs and with exposed surfaces finished for ends of thresholds and for similar applications that would otherwise expose unfinished brick surfaces.
- B. ASTM C 27 and as follows:
 1. Classification: Medium-duty
 2. Size: Manufactured to the actual dimensions 9" x 4-1/2" x 2-1/2".
 3. Application: Place tight with no mortar on floors where indicated.

2.3 PRECAST CONCRETE LINTELS

- A. Concrete Lintels: Precast concrete lintels complying with requirements in Division 03 Section "Cast-in-Place Concrete" and with reinforcing bars indicated in the Contract Drawings.

- B. Provide precast concrete lintels where shown and where openings of more than 12 inches for brick size units and 24 inches for block size units are shown without other supporting lintels.
- C. Where indicated on the Drawings, provide precast refractory concrete lintels per the following requirements.
 - 1. Provide precast refractory concrete lintels made with refractory concrete, consisting of calcium aluminate cement and fired aggregates, with a minimum ultimate compressive strength of 5,000 psi, reinforced and configured as indicated on the drawings. Cure precast lintels before handling and installing. Lintels shall be warranty items that must not be damaged during the warranty period by repetitive live fire training, including exposures to temperatures up to 1,800 degrees F and thermal shock due to water application.
 - 2. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include the following:
 - a. Precast refractory lintels as provided by High Temperature Linings, P. O. Box 1240, White Stone, VA 22578; (800) 411-6313; www.firetrain.com.
 - b. Precast lintels using Fondag RS refractory concrete as provided by Kerneos Aluminate Technologies, 1316 Priority Lane, Chesapeake, VA 23324; (757) 284-3200; www.kerneosinc.com.
- D. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated.

2.4 MASONRY LINTELS

- A. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs with reinforcing bars placed as indicated and filled with coarse grout. CMU lintels shall match adjacent masonry color and texture. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.
- B. Provide lintels where shown and where openings of more than 12 inches for brick size units and 24 inches for block size units are shown without other supporting lintels.
- C. Provide minimum bearing of 24 inches at each jamb, unless otherwise indicated.
- D. Match block colors and textures for surrounding wall in which the lintel is placed.

2.5 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. Masonry Cement: ASTM C 91.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
 - a. Lafarge North America Inc.; Magnolia Masonry Cement or Lafarge Masonry Cement.
 - b. Lehigh Cement Company; Lehigh Masonry Cement.
 - c. Holcim (US) Inc.; Mortarmix Masonry Cement.
- E. Aggregate for Mortar: ASTM C 144; except for joints less than 1/4 inch, use aggregate graded with 100 percent passing the No. 16 sieve.
- F. Aggregate for Grout: ASTM C 404.
- G. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
 - a. Euclid Chemical Company (The); Accelguard 80.
 - b. Grace Construction Products, W. R. Grace & Co. - Conn.; Morset.
 - c. Sonneborn Products, BASF; Trimix-NCA.
- H. Water-Repellent Admixture: Liquid or powder water-repellent mortar admixture intended for mortar used with CMUs containing integral water repellent by same manufacturer.
 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
 - a. ACM Chemistries; RainBloc for Mortar.
 - b. Cargill, Inc.; Acme Shield Mortar Admixture.
 - c. Euclid Chemical Company; Blocktite Mortar Admixture.
 - d. Euclid Chemical Company; Hydrapel Mortar Admixture.
 - e. GCP Applied Technologies, Inc.; Dry-Block Mortar Admixture.
 - f. Master Builders; MasterPel 240 Mortar Admixture.
 2. Add water repellent admixture to mortar as recommended by water repellent manufacturer for specific mortar mix used, to achieve maximum water repellency in addition to efflorescence control.
 - a. Water repellency requirements shall match those of the block that has integral water repellent when tested as a wall assembly according to ASTM E 514.
 3. Water repellent admixture in mortar shall be compatible with the CMU, including compatible with the integral water repellent admixture used to manufacture the CMU.
- I. Water: Potable.

2.6 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars: ASTM A 615, Grade 60.

2.7 MASONRY JOINT REINFORCEMENT

- A. General: ASTM A 951
- B. Provide joint reinforcement formed from the following:
 - 1. Hot-dip galvanized carbon-steel wire, coating class as follows:
 - a. ASTM A 153, Class B-2, for both interior and exterior walls.
- C. Description: Welded-wire units prefabricated with deformed continuous side rods and plain cross rods into straight lengths of not less than 10 feet, with prefabricated corner and tee units, and complying with requirements indicated below:
 - 1. Wire Diameter for Side Rods: 0.1483 inch.
 - 2. Wire Diameter for Cross Rods: 0.1483 inch.
- D. For single-wythe masonry, provide type as follows with single pair of side rods:
 - 1. Ladder or truss type spaced not more than 16 inches o.c.
- E. For double-wythe cavity wall masonry, provide type as follows spaced not more than 16 inches o.c.:
 - 1. Seismic adjustable (two-piece) ladder type, with one side rod at each face shell of backing wythe, one side rod in facing wythe, and separate ties that extend into facing wythe. Ties shall have two hooks that engage eyes or slots in backing wythe reinforcement and resist movement perpendicular to wall. Ties shall extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face. Ties shall have hooks, indentions, or clips to engage the continuous horizontal wire in the facing wythe.
- 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 steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

2.8 TIES AND ANCHORS, GENERAL

- A. General: Provide ties and anchors specified in subsequent articles that comply with requirements for metal and size of this Article, unless otherwise indicated.
- B. Steel Sheet: As follows:
 - 1. Galvanized Steel Sheet: ASTM A 653, G 60 (commercial quality), steel sheet zinc coated by hot-dip process on continuous lines prior to fabrication, for sheet-metal ties and anchors.

- C. Galvanized Steel Sheet Thickness: For steel sheet hot-dip galvanized by continuous process prior to fabrication:
 - 1. 0.1084 inch (12 gauge).
- D. Thickness of Steel Sheet Galvanized After Fabrication: Uncoated thickness of steel sheet for hot-dip galvanizing after fabrication:
 - 1. 0.1046 inch (12 gauge).

2.9 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.
- B. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

2.10 MASONRY CLEANERS

- A. Manufactured Masonry Detergent: Detergent based solution designed for the cleaning of new masonry structures.
 - 1. Products:
 - a. EaCo Chem NMD 80.
 - b. Approved equal meeting the specifications.
- B. Manufacturer shall provide on-site training for the application and cleaning of the masonry.
- C. Pre-test application on masonry prior to full-scale cleaning.
 - 1. Allow masonry to fully dry prior to evaluation of test for final appearance and results.
 - 2. Test all adjacent construction materials (metals, concrete, and other materials) to confirm the cleaning product does not damage finish.
- D. Protect adjacent materials from cleaning solution.
- E. Comply with all manufacturer's instructions and recommendations for the storage and handling of the product, mixing, testing, application, and rinsing of the masonry.

2.11 MORTAR AND GROUT MIXES

- A. General: Other than liquid water-repellent mortar admixture, do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, antifreeze compounds, or other admixtures, unless otherwise indicated.
 - 1. Do not use calcium chloride in mortar or grout.

- B. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification, for types of mortar indicated below:
 - 1. For all masonry, use type S.
- C. Integral water repellent: Mortar shall include an integral water repellent compatible with the integral water repellent in the concrete masonry units.
- D. Grout for Unit Masonry: Comply with ASTM C 476. Minimum compressive strength shall be 3,000 psi. Use grout of consistency (fine or coarse) at time of placement that will completely fill spaces intended to receive grout.
 - 1. Use fine grout in grout spaces less than 2 inches in horizontal dimension, unless otherwise indicated.
 - 2. Use coarse grout in grout spaces 2 inches or more in least horizontal dimension, unless otherwise indicated.
 - 3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143.

2.12 INTEGRAL WATER REPELLENT FOR MASONRY UNITS AND MORTAR

- A. Concrete masonry units shall be manufactured with an integral water-repelling polymer admixture compatible with the masonry mix, mortar, and grout.
- B. Mortar shall be mixed with water-repelling mortar admixture.

2.13 MASONRY SEALER

- A. Modified silane, “breathable”, low volatility, penetrating water repellent providing invisible coating for concrete masonry construction. Water repellent coating shall protect against water and waterborne contaminants.
- B. Water repellent sealer shall be non-solvent based.
- C. Clear, not-glossy finish.
- D. Manufacturer:
 - 1. Prosoco; Sure Klean SL100 Water Repellent.
 - 2. Approve equal meeting the specifications.

2.14 CAST-IN-PLACE MASONRY WALL CAPS

- A. Provide a cast-in-place masonry wall cap at all masonry parapets, knee walls, or cubicle walls per details in the Construction Documents.
- B. Cast-in-place concrete caps shall be either:

- a. The 4,500 psi, air-entrained, ready-mix concrete from concrete specification 033000.1, for which pumping would be allowed as well as other means & methods as long as concrete and finish meet the requirements of the concrete specification, or
- b. 4,500 psi, air-entrained Quikrete (Quikrete Q-Max Pro), mixed in a mixer on site (not mixed in a wheelbarrow), with the fibers that project from the surface rubbed off after final cure and with finish that meets the requirements of the concrete specification.

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 unit masonry. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

3.2 INSTALLATION, GENERAL

- A. Build cavity walls and other masonry construction to full thickness shown. Build single-wythe walls to the actual thickness of the masonry units, using units of thickness indicated.
- B. Build chases and recesses to accommodate items specified in this and other Sections of the Specifications.
- C. Leave openings for equipment to be installed before completion of masonry. After installing equipment, complete masonry to match construction immediately adjacent to the 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 masonry units with motor-driven saws to provide clean, sharp, unchipped edges. Allow units cut with water-cooled saws to dry before placing, 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.

3.3 LOOSE LAID FIRE BRICK ON FLOORS

- A. Install loose-laid fire brick on floors where indicated, with joints between bricks tight and no mortar. Place bricks so that 9" x 4-1/2" face is placed on floor.

3.4 CONSTRUCTION TOLERANCES

- A. Variation from Plumb: For vertical lines and surfaces of walls, do not exceed 1/4 inch in 10 feet, nor 3/8 inch in 20 feet, nor 1/2 inch in 40 feet or more. For external corners, expansion joints, control joints, and other conspicuous lines, do not exceed 1/4 inch in 20 feet, nor 1/2 inch in 40 feet or more. For vertical alignment of head joints, do not exceed plus or minus 1/4 inch in 10 feet, nor 1/2 inch maximum.
- B. Variation from Level: For bed joints and lines of exposed lintels, sills, and other conspicuous lines, do not exceed 1/4 inch in 20 feet, nor 1/2 inch in 40 feet or more.
- C. Variation in Cross-Sectional Dimensions: From dimensions shown, do not exceed minus 1/4 inch nor plus 1/2 inch.
- D. Variation in Mortar-Joint Thickness: Do not vary from joint thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch. Do not vary joint thickness from joint thickness of adjacent course by more than 1/8 inch.

3.5 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint widths and for accurate location of openings, movement-type joints, returns, and offsets. Avoid the use of less-than-half-size units at corners, jambs, and where possible at other locations.
- B. Lay walls to comply with specified construction tolerances, with courses accurately spaced and coordinated with other construction.
- C. Bullnose Block: At interior walls and partitions, provide bullnose block at all outside corners.
- D. Bond Pattern: Lay masonry in the following bond pattern; bond and interlock each course of each wythe at corners unless interrupted by a thru-wall expansion joint; do not use units with less than nominal 8-inch horizontal face dimensions at corners or jambs.
 - 1. One-half running bond with vertical joint in each course centered on units in courses above and below.
- E. Stopping and Resuming Work: In each course, rack back 1/2-unit length; do not tooth. Clean exposed surfaces of set masonry, wet clay masonry units lightly if required, and remove loose masonry units and mortar prior to laying fresh masonry.
- F. Built-in Work: As construction progresses, build-in items specified under this and other Sections of the Specifications. Fill in solidly with masonry around built-in items.
- G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath in the joint below and rod mortar or grout into core.
- H. Fill cores in hollow concrete masonry units with grout full height as follows:
 - 1. All cores in exterior walls of training tower.

2. Cores containing vertical reinforcing in exterior walls of burn building and all interior walls.
 3. All jambs at door and window openings.
 4. Other locations indicated on the drawings.
- I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

3.6 MORTAR BEDDING AND JOINTING

- A. Lay hollow concrete masonry units as follows:
1. With completely filled bed and head joints. Butter ends of units with sufficient mortar to completely fill head joints. Provide full bed joints, including face shells and webs.
 2. Maintain joint widths indicated, except for minor variations required to maintain bond alignment. If not indicated, lay walls with 3/8-inch joints.
- 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 furrow bed joints or slush head joints.
- C. Tool joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.

3.7 MASONRY JOINT REINFORCEMENT

- A. General: Provide continuous horizontal-joint reinforcement as indicated. Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch. Lap reinforcement a minimum of 6 inches.
1. Space reinforcement not more than 16 inches o.c.
- B. Cut or interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.
- C. Provide continuity at corners and wall intersections by using prefabricated "L" and "T" sections.
- D. Cut and bend reinforcement units as directed by manufacturer for continuity at returns, offsets, pipe enclosures, and other special conditions.

3.8 PLACING REINFORCEMENT

- A. General: Comply with requirements in TMS 402-11 / ACI 30-11 / ASCE5-11.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with grout.
- C. Accurately position, support, and secure reinforcement against displacement.

3.9 CONTROL AND EXPANSION JOINTS

- A. General: Install control and expansion joints in unit masonry where indicated. Build-in related items as the masonry progresses. Do not form a continuous span through movement joints.

3.10 LINTELS

- A. Provide precast concrete lintels where shown and where openings of more than 12 inches (for brick size units) and 24 inches (for block size units) are shown without other supporting lintels.
- B. Provide masonry lintels where shown and where openings of more than 24 inches are shown without other supporting lintels.
- C. Provide minimum bearing shown on drawings.

3.11 GROUTING

- A. Do not place grout until entire height of masonry to be grouted has attained sufficient 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. Provide cleanout holes at least 3 inches in least dimension for grout pours over 60 inches in height.

3.12 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or if units 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 prior to tooling joints. Remove excess mortar from all vertical expansion joints and remove excess mortar and grout from any horizontal expansion joints at tops of all masonry walls.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 - 1. Beginning from the top of the wall, lightly pre-wet or pre-cool the wall;
 - 2. Begin applying cleaning material from the top to bottom, using even, overlapping passes to ensure full coverage of chemical on the surface;

- a. Apply cleaning material to the entire drop or section of wall that can be cleaned without allowing the chemical to dry on the surface.
3. After the first application of cleaning material, scrape the large chunks with a long handled scrapper from the first 8 feet of wall;
 - a. Use a scrapper in accordance to masonry manufacturers' requirements.
4. Check smears and tags to see if they crumble easily;
5. If needed, repeat application to melt remaining residue and extend dwell time;
6. After re-application, scrapping can be done further down the wall;
7. Once smears and tags crumble easily, begin rinsing from top down. A thorough rinse is necessary to avoid leaving any cleaning material on the surface or in the masonry unit.
 - a. Use long even strokes that overlap each other.
 - b. Rinse pressure is determined by the masonry manufacturers' requirements. Color sensitive surfaces should always be rinsed with low pressure.
- E. Protection: Provide final protection and maintain conditions that ensure unit masonry is without damage and deterioration at time of Substantial Completion.

3.13 WATER REPELLENT SEALER

- A. Provide water repellent sealer on exterior face of all exterior CMU walls at the training tower.
- B. After final cleaning and masonry is thoroughly dry, ensure that surfaces are clean and free of dust, surface dirt, oil, grease and other contaminants.
- C. Test application: Provide test application and allow to fully cure prior to evaluation for appearance and performance. Do not proceed until approval of final appearance.
- D. Protect adjacent construction materials from sealer as recommended by the manufacturer.
- E. Ensure there is adequate ventilation and that there are no potential ignition sources prior to application.
- F. Apply the sealer per manufacturer's recommendations.

3.14 QUALITY CONTROL DURING CONSTRUCTION

- A. General: The Owner will employ a testing agency to perform tests and inspections and to submit testing and inspection reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.
- B. Perform visual inspections of at least 75% of masonry placement, checking for reinforcement placement, mortar placement, joint placement, anchorage placement, and grouting.

- C. Testing Frequency: Tests listed in this Article will be performed during construction for each 2,000 sq. ft. of wall area or portion thereof, but no less than three of each test for the Project if there is less than 6,000 square feet of wall surface for the Project.
- D. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.
- E. Compressive-Strength Tests for Grout: Test grout cylinders or cubes for compressive strength per ASTM C 1019 as follows:
 - 1. Prepare 1 set of laboratory-cured specimens, cylinders or cubes, for testing as follows: one specimen tested at 7 days, two specimens tested at 28 days, and one spare specimen to be held in reserve for later testing if required.
- F. Mortar Aggregate Ratio Test: For each type provided, test mortar for consistency of materials and procedures per ASTM C 780.
- G. Test results shall be reported in writing to Engineer and Contractor within 24 hours after tests. Reports of strength tests shall contain the Project identification name and number, date of masonry placement, name of testing service, masonry type and class, location of masonry in structure, and compressive breaking strength for both 7-day tests and 28-day tests.

END OF SECTION 04 20 00.01

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. Prefabricated building columns.
 - 3. Shear stud connectors.
 - 4. Shrinkage-resistant grout.
- B. Related Requirements:
 - 1. Section 053100 "Steel Decking" for field installation of shear stud connectors through deck.
 - 2. Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" and Section 099600 "High-Performance Coatings" for painting requirements.

1.3 DEFINITIONS

- A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in ANSI/AISC 303.
- B. Heavy Sections: Rolled and built-up sections as follows:
 - 1. Shapes included in ASTM A6/A6M with flanges thicker than 1-1/2 inches.
 - 2. Welded built-up members with plates thicker than 2 inches.
 - 3. Column base plates thicker than 2 inches.
- C. Demand-Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the seismic-load-resisting system and which are indicated as "demand critical" or "seismic critical" on Drawings.

1.4 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 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. Product Data:

1. Structural-steel materials.
2. High-strength, bolt-nut-washer assemblies.
3. Anchor rods.
4. Threaded rods.
5. Forged-steel hardware.
6. Shop primer.
7. Galvanized-steel primer.
8. Etching cleaner.
9. Galvanized repair paint.
10. Shrinkage-resistant grout.

- B. Shop Drawings: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Include embedment Drawings.
3. 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.
4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
5. Identify members and connections of the seismic-load-resisting system.
6. Indicate locations and dimensions of protected zones.
7. Identify demand-critical welds.
8. Identify members not to be shop primed.

- C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide in accordance with AWS D1.1/D1.1M for each welded joint whether prequalified or qualified by testing, including the following:

1. Power source (constant current or constant voltage).
2. Electrode manufacturer and trade name, for demand-critical welds.

- D. Delegated-Design Submittal: For structural-steel connections indicated on Drawings to comply with design loads, include analysis data 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 to verify that the

connections detailed comply with the calculations provided as well as the design requirements. A review letter, signed and sealed by the professional engineer responsible for connection design, shall be provided with the shop drawings and calculations submittal stating that this review and verification has been completed.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.
- B. Welding certificates.
- 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 materials, including chemical and physical properties.
- E. Product Test Reports: For the following:
 - 1. Bolts, nuts, and washers, including mechanical properties and chemical analysis.
 - 2. Direct-tension indicators.
 - 3. Tension-control, high-strength, bolt-nut-washer assemblies.
 - 4. Shear stud connectors.
- F. Source quality-control reports.
- G. Field quality-control reports.

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 BU or is accredited by the IAS Fabricator Inspection Program for Structural Steel (Acceptance Criteria 172).
- B. Installer Qualifications: A qualified Installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category ACSE.
- C. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.
 - 1. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8/D1.8M. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.

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 F3125/F3125M, Grade F1852 bolt assemblies and for retesting bolt assemblies after lubrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with applicable provisions of the following specifications and documents:
 - 1. ANSI/AISC 303.
 - 2. ANSI/AISC 341.
 - 3. ANSI/AISC 360.
 - 4. RCSC's "Specification for Structural Joints Using High-Strength Bolts."
- B. Connection Design Information:
 - 1. Option 2: Fabricator's experienced steel detailer shall select or complete connections in accordance with ANSI/AISC 303.
 - a. Select and complete connections using schematic details indicated and ANSI/AISC 360.
 - b. Use Load and Resistance Factor Design; data are given at factored-load level.
- C. Moment Connections: Type PR, partially restrained.
- D. Construction: Moment frame.

2.2 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: ASTM A992/A992M.
- B. Channels, Angles: ASTM A36/A36M.

- C. Plate and Bar: ASTM A36/A36M.
- D. Corrosion-Resisting (Weathering) Structural-Steel Shapes, Plates, and Bars: ASTM A588/A588M, 50 ksi.
- E. Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade C structural tubing.
- F. Corrosion-Resisting (Weathering), Cold-Formed Hollow Structural Sections: ASTM A847/A847M structural tubing.
- G. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS AND CONNECTORS

- A. High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.
 - 1. Direct-Tension Indicators: ASTM F959/F959M, Type 325-1, compressible-washer type with plain finish.
- B. Zinc-Coated High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.
 - 1. Finish: Hot-dip or mechanically deposited zinc coating.
 - 2. Direct-Tension Indicators: ASTM F959/F959M, Type 325-1, compressible-washer type with mechanically deposited zinc coating finish.
- C. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 1, heavy-hex head assemblies, consisting of steel structural bolts with splined ends; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.
 - 1. Finish: Mechanically deposited zinc coating.
- D. Shear Stud Connectors: ASTM A108, AISI C-1015 through C-1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

2.4 RODS

- A. Unheaded Anchor Rods: ASTM F1554, Grade 36.
 - 1. Configuration: Straight.
 - 2. Nuts: ASTM A563 heavy-hex carbon steel.
 - 3. Plate Washers: ASTM A36/A36M carbon steel.
 - 4. Washers: ASTM F436, Type 1, hardened carbon steel.
 - 5. Finish: Hot-dip zinc coating, ASTM A153/A153M, Class C.

B. Threaded Rods: ASTM A36/A36M.

1. Nuts: ASTM A63 heavy-hex carbon steel.
2. Washers: ASTM F436, Type 1, hardened carbon steel.
3. Finish: Hot-dip zinc coating, ASTM A153/A153M, Class C.

2.5 PRIMER

A. Steel Primer:

1. Comply with Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."
2. SSPC-Paint 23, latex primer.
3. Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

B. Galvanized-Steel Primer:

1. Etching Cleaner: MPI#25, for galvanized steel.
2. Galvanizing Repair Paint: ASTM A780/A780M.

2.6 SHRINKAGE-RESISTANT GROUT

- A. Metallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.
- B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.7 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with ANSI/AISC 303 and to ANSI/AISC 360.
1. Camber structural-steel members where indicated.
 2. Fabricate beams with rolling camber up.
 3. Identify high-strength structural steel in accordance with ASTM A6/A6M and maintain markings until structural-steel framing 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. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural-steel frame. Straighten as required to provide uniform, square, and true members in completed wall framing. Build up welded framing, weld exposed joints continuously, and grind smooth.
- F. Welded-Steel Door Frames: Build up welded-steel door frames attached to structural-steel frame. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk machine screws, uniformly spaced not more than 10 inches o.c. unless otherwise indicated on Drawings.
- G. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel 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.

2.8 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M 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 maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

2.9 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel in accordance with ASTM A123/A123M.
 - 1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.

2.10 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 unless indicated to be painted.
6. Corrosion-resisting (weathering) steel surfaces.
7. Surfaces enclosed in interior construction.

B. Surface Preparation of Steel: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces in accordance with the following specifications and standards:

1. SSPC-SP 2.
2. SSPC-SP 3.
3. SSPC-SP 7 (WAB)/NACE WAB-4.
4. SSPC-SP 14 (WAB)/NACE WAB-8.
5. SSPC-SP 11.
6. SSPC-SP 6 (WAB)/NACE WAB-3.
7. SSPC-SP 10 (WAB)/NACE WAB-2.
8. SSPC-SP 5 (WAB)/NACE WAB-1.
9. SSPC-SP 8.

C. Surface Preparation of Galvanized Steel: Prepare galvanized-steel surfaces for shop priming by thoroughly cleaning steel of grease, dirt, oil, flux, and other foreign matter, and treating with etching cleaner or in accordance with SSPC-SP 16.

D. Priming: Immediately after surface preparation, apply primer in accordance with 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.

2.11 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform shop tests and inspections.

1. Allow testing agency access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
2. Bolted Connections: Inspect shop-bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
3. Welded Connections: Visually inspect shop-welded connections in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
 - a. Liquid Penetrant Inspection: ASTM E165/E165M.

- b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
 - c. Ultrasonic Inspection: ASTM E164.
 - d. Radiographic Inspection: ASTM E94/E94M.
- 4. In addition to visual inspection, test and inspect shop-welded shear stud connectors in accordance with requirements in AWS D1.1/D1.1M for stud welding and as follows:
 - a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear stud connector.
 - b. Conduct tests in accordance with requirements in AWS D1.1/D1.1M on additional shear stud connectors if weld fracture occurs on shear stud connectors already tested.
- 5. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify, with certified 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 existing conditions. Include 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 on Drawings.
 - 1. Do not remove temporary shoring supporting composite deck construction and structural-steel framing 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 in accordance with ANSI/AISC 303 and ANSI/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 shrinkage-resistant 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 grouting.
- C. Maintain erection tolerances of structural steel within ANSI/AISC 303.
- D. 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 are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
1. Level and plumb individual members of structure. Slope roof framing members to slopes indicated on Drawings.
 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated.
- F. Do not use thermal cutting during erection.
- G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt and joint type specified.
1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
1. Comply with ANSI/AISC 303 and ANSI/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, back gouge, and grind steel smooth.
 3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

3.5 INSTALLATION OF PREFABRICATED BUILDING COLUMNS

- A. Install prefabricated building columns to comply with ANSI/AISC 360, manufacturer's written recommendations, and requirements of testing and inspecting agency that apply to the fire-resistance rating indicated.

3.6 REPAIR

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing, and repair galvanizing to comply with ASTM A780/A780M.
- B. Touchup Painting:
 - 1. Immediately after erection, clean exposed areas where primer is damaged or missing, and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
 - 2. Cleaning and touchup painting are specified in Section 099113 "Exterior Painting."
- C. Touchup Priming: Cleaning and touchup priming are specified in Section 099600 "High-Performance Coatings."

END OF SECTION 051200

SECTION 052100 - STEEL JOIST 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. K-series steel joists.
 - 2. K-series steel joist substitutes.
 - 3. Steel joist accessories.
- B. Related Requirements:
 - 1. Section 033000 "Cast-in-Place Concrete" for installing bearing plates in concrete.
 - 2. Section 042000 "Unit Masonry" for installing bearing plates in unit masonry.
 - 3. Section 051200 "Structural Steel Framing" for field-welded shear connectors.

1.3 DEFINITIONS

- A. SJI's "Specifications": Steel Joist Institute's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders."
- B. Special Joists: Steel joists or joist girders requiring modification by manufacturer to support nonuniform, unequal, or special loading conditions that invalidate load tables in SJI's "Specifications."

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of joist, accessory, and product.
- B. Shop Drawings:
 - 1. Include layout, designation, number, type, location, and spacing of joists.
 - 2. Include joining and anchorage details; bracing, bridging, and joist accessories; splice and connection locations and details; and attachments to other construction.
 - 3. Indicate locations and details of bearing plates to be embedded in other construction.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Welding certificates.
- C. Manufacturer certificates.
- D. Mill Certificates: For each type of bolt.
- E. Comprehensive engineering analysis of special joists signed and sealed by the qualified professional engineer responsible for its preparation.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables in SJI's "Specifications."
 - 1. include providing professional engineering services for designing special joists to comply with performance requirements.
- B. Welding Qualifications: Qualify field-welding procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle joists as recommended in SJI's "Specifications."
- B. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

1.8 SEQUENCING

- A. Deliver steel bearing plates to be built into masonry construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated on Drawings.
 - 1. Use ASD; data are given at service-load level.

2. Design special joists to withstand design loads with live-load deflections no greater than the following:
 - a. Roof Joists: Vertical deflection of 1/240 of the span.

2.2 STEEL JOISTS

- A. K-Series Steel Joist: Manufactured steel joists of type indicated according to "Standard Specification for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord.
 1. Joist Type: K-series steel joists.
 2. K-Series Steel Joist Substitutes: Manufacture according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle or -channel members.
 3. Top-Chord Extensions: Extend top chords of joists with SJI's Type S top-chord extensions where indicated on Drawings, complying with SJI's "Specifications."
 4. Extended Ends: Extend bearing ends of joists with SJI's Type R extended ends where indicated on Drawings, complying with SJI's "Specifications."
 5. Camber steel joists according to SJI's "Specifications."
 6. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches (1:48).

2.3 PRIMERS

- A. Primer:
 1. SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.
 2. Provide shop primer that complies with Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

2.4 STEEL JOIST ACCESSORIES

- A. Bridging:
 1. Provide bridging anchors and number of rows of horizontal or diagonal bridging of material, size, and type required by SJI's "Specifications" for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.
- B. Fabricate steel bearing plates from ASTM A36/A36M steel with integral anchorages of sizes and thicknesses indicated on Drawings. Shop prime paint.
- C. Furnish ceiling extensions, either extended bottom-chord elements or a separate extension unit of enough strength to support ceiling construction.
 1. Extend ends to within 1/2 inch (13 mm) of finished wall surface unless otherwise indicated on Drawings.
 2. Finish: Plain, uncoated.

- D. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325 (Grade A325M), Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, (ASTM A563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.
 - 1. Finish: Plain.
- E. Welding Electrodes: Comply with AWS standards.
- F. Furnish miscellaneous accessories including splice plates and bolts required by joist manufacturer to complete joist assembly.

2.5 CLEANING AND SHOP PAINTING

- A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories by hand-tool cleaning, SSPC-SP 2 or power-tool cleaning, SSPC-SP 3.
- B. Do not prime paint joists and accessories to receive sprayed fire-resistive materials.
- C. Apply one coat of shop primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 1 mil (0.025 mm) thick.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting substrates, embedded bearing plates, and abutting structural framing 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. Do not install joists until supporting construction is in place and secured.
- B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications" joist manufacturer's written instructions, and requirements in this Section.
 - 1. Before installation, splice joists delivered to Project site in more than one piece.
 - 2. Space, adjust, and align joists accurately in location before permanently fastening.
 - 3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
 - 4. Do not rigidly connect bottom-chord extensions to columns or supports.
- C. Field weld joists to supporting steel bearing plates and framework. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and

procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

- D. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

3.3 REPAIRS

A. Touchup Painting:

- 1. Immediately after installation, clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists, bearing plates, abutting structural steel, and accessories.
 - a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
 - b. Apply a compatible primer of same type as primer used on adjacent surfaces.

END OF SECTION 052100

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. Section Includes:
 - 1. Roof deck.
- B. Related Requirements:
 - 1. Section 051200 "Structural Steel Framing" for shop- and field-welded shear connectors.

1.3 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Roof deck.
- B. Shop Drawings:
 - 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.
- C. Product Test Reports: For tests performed by a qualified testing agency, indicating that each of the following complies with requirements:
 - 1. Power-actuated mechanical fasteners.
- D. Research Reports: For steel deck, from ICC-ES.
- E. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. 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.

PART 2 - PRODUCTS

2.1 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. Fire-Resistance Ratings: Comply with ASTM E119; 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 ROOF DECK

- A. 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:
 - 1. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade 33, G60 zinc coating.
 - 2. Deck Profile: As indicated.
 - 3. Profile Depth: As indicated.
 - 4. Design Uncoated-Steel Thickness: As indicated.
 - 5. Span Condition: Triple span or more.
 - 6. Side Laps: Overlapped or interlocking seam at Contractor's option.

2.3 ACCESSORIES

- A. 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. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
- E. 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.
- F. 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.
- G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.
- H. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.
- I. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0598 inch thick, with factory-punched hole of 3/8-inch minimum diameter.
- J. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck. For drains, cut holes in the field.
- K. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck, with 3-inch-wide flanges and [level] [sloped] recessed pans of 1-1/2-inch minimum depth. For drains, cut holes in the field.
- L. Galvanizing Repair Paint: ASTM A780/A780M.
- M. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

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 of the Work.
- 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. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
- G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
- H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
- I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

3.3 INSTALLATION OF ROOF DECK

- A. Fasten roof-deck panels to steel supporting members as indicated.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports as indicated.
- 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 or butted at Contractor's option.
- D. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and mechanically fasten flanges to top of deck. Space mechanical fasteners not more than 12 inches apart with at least one fastener at each corner.
 - 1. Install reinforcing channels or zees in ribs to span between supports and weld or mechanically fasten.
- 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 or mechanically fasten to substrate to provide a complete deck installation.

1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.

- F. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.

3.4 REPAIR

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.
- B. Repair Painting:
 1. Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.
 2. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.
 3. Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
 4. Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Field welds will be subject to inspection.
- C. Prepare test and inspection reports.

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. Section Includes:
 - 1. Roof joist framing.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 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 Submittal: At Contractor's option for exterior wall framing (load bearing and non-load bearing), load-bearing interior wall framing, roof joist framing and flat strapped shearwalls.

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. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

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. Basis of Design: Basis of design for metal strapped shear walls is The Steel Network StiffWall Shear Wall System. Contractor may provide delegated design submittal for alternative equivalent system subject to review and approval of Architect and Structural Engineer. If alternative system is proposed, Contractor shall submit calculations and shop drawings signed and sealed by a qualified professional engineer registered in the State of North Carolina. System must be designed for ultimate wind loads designated on drawings and in compliance with ASCE 7-10 / 2018 North Carolina Building Code).
- B. Cold-Formed Steel Framing Design Standards:
 - 1. Floor and Roof Systems: Design according to AISI S210.
 - 2. Lateral Design: Design according to AISI S213.

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: ST50H.
 - 2. Coating: G60.

2.2 ROOF JOIST FRAMING

- A. Steel Joists: Manufacturer's standard C-shaped steel joists, of web depths indicated, unpunched with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0428 inch.
 - 2. Flange Width: 2 inches.

- B. Steel Joist Track: Manufacturer's standard U-shaped steel joist track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0428 inch.
 - 2. Flange Width: 1-1/4 inches, minimum.

2.3 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. Gusset plates.
 - 8. Stud kickers and knee braces.
 - 9. Joist hangers and end closures.
 - 10. Hole reinforcing plates.
 - 11. Backer plates.

2.4 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/A 153M, Class C.
- C. Expansion Anchors: Fabricated from corrosion-resistant materials, 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 per ASTM E 488 conducted by a qualified testing agency.
- D. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E 1190 conducted by a qualified 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.

2.5 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: ASTM A 780.
- B. Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, 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.
- C. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, and plasticizing and water-reducing agents, complying with ASTM C 1107/C 1107M, with fluid consistency and 30-minute working time.
- D. Shims: Load bearing, high-density multimonomer plastic, and nonleaching; or of cold-formed steel of same grade and coating as framing members supported by shims.

2.6 FABRICATION

- A. Fabricate cold-formed steel 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 steel framing members by screw fastening. Wire tying of framing members is not permitted.
 - a. 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 steel 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 steel 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 of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Install load bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch to ensure a uniform bearing surface on supporting concrete or masonry construction.

3.3 INSTALLATION, GENERAL

- A. Cold-formed steel 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 steel 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 steel 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.
- 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 joints with cold-formed steel framing. Independently frame both sides of joints.
- H. Install insulation, specified in Section 072100 "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 approved or standard punched openings.
- J. Erection Tolerances: Install cold-formed steel 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 JOIST INSTALLATION

- A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated on Shop Drawings.
- B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.
 - 1. Install joists over supporting frame with a minimum end bearing of 1-1/2 inches.
 - 2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections as indicated on Shop Drawings.
- C. Space joists not more than 2 inches from abutting walls, and as follows:
 - 1. Joist Spacing: As indicated.
- D. Frame openings with built-up joist headers consisting of joist and joist track, or another combination of connected joists if indicated.
- E. Install joist reinforcement at interior supports with single, short length of joist section located directly over interior support, with lapped joists of equal length to joist reinforcement, or as indicated on Shop Drawings.
 - 1. Install web stiffeners to transfer axial loads of walls above.
- F. Install bridging at intervals indicated on Shop Drawings. Fasten bridging at each joist intersection as follows:
 - 1. Bridging: Joist-track solid blocking of width and thickness indicated, secured to joist webs.
- G. Secure joists to load-bearing interior walls to prevent lateral movement of bottom flange.

- H. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

3.5 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel 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 steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 054000

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 operable partitions.
2. Steel framing and supports for countertops.
3. Steel framing and supports for mechanical and electrical equipment.
4. Steel framing and supports for applications where framing and supports are not specified in other Sections.
5. Shelf angles.
6. Metal ladders.
7. Ladder safety cages.
8. Alternating tread devices.
9. Structural-steel door frames.
10. Miscellaneous steel trim including steel angle corner guards and steel edgings.
11. Metal bollards.
12. Pipe guards.
13. Abrasive metal nosings, treads and thresholds.
14. Metal downspout boots.
15. Loose bearing and leveling plates for applications where they are not specified in other Sections.

- 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 042000 "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.
2. Section 051200 "Structural Steel Framing" for steel framing, supports, door frames, and other steel items attached to the structural-steel framing.

1.3 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.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Nonslip aggregates and nonslip-aggregate surface finishes.
 - 2. Shrinkage-resisting grout.
 - 3. Paint products.
 - 4. Abrasive metal nosings and treads.
- 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 operable partitions.
 - 2. Steel framing and supports for countertops.
 - 3. Steel framing and supports for mechanical and electrical equipment.
 - 4. Steel framing and supports for applications where framing and supports are not specified in other Sections.
 - 5. Shelf angles.
 - 6. Metal ladders.
 - 7. Ladder safety cages.
 - 8. Structural-steel door frames.
 - 9. Metal bollards.
 - 10. Loose steel lintels.
- C. Samples for Verification: For each type and finish of extruded nosing and tread.
- 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 D.1/D1.1M, "Structural Welding Code – Steel."
- B. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.7 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. 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. 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 (67 deg C), ambient; 180 deg F (100 deg C), 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 A36/A36M.
- C. Stainless Steel Sheet, Strip, and Plate: ASTM A240/A240M or ASTM A666, Type 304.
- D. Stainless Steel Bars and Shapes: ASTM A276/A276M, Type 304.
- E. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or D.
- F. Rolled-Stainless Steel Floor Plate: ASTM A793.
- G. Abrasive-Surface Floor Plate: Steel plate [with abrasive granules rolled into surface] [or] [with abrasive material metallurgically bonded to steel].
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Harsco Industrial IKG, a Division of Harsco Corporation.
 - b. ROSS TECHNOLOGY CORP.
 - c. W.S. Molnar Company.
- H. Steel Tubing: ASTM A500/A500M, galvanized cold-formed steel tubing.
- I. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.
- J. Zinc-Coated Steel Wire Rope: ASTM A741.
 - 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.

- K. 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 (41 by 41 mm).
 - 2. Material: Galvanized steel, ASTM A653/A653M, structural steel, Grade 33 (Grade 230), with G90 (Z275) coating; 0.079-inch (2-mm) nominal thickness.
 - 3. Material: Cold-rolled steel, ASTM A1008/A1008M, commercial steel, Type B; minimum thickness; coated with rust-inhibitive, baked-on, acrylic enamel.
- L. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

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 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.
 - 2. Provide stainless steel fasteners for fastening nickel silver.
 - 3. Provide bronze fasteners for fastening bronze.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A (ASTM F568M, Property Class 4.6); with hex nuts, ASTM A563 (ASTM A563M); and, where indicated, flat washers.
- C. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325 (Grade A325M), Type 3, heavy-hex steel structural bolts; ASTM A563, Grade DH3, (ASTM A563M, Class 10S3) heavy-hex carbon-steel nuts; and where indicated, flat washers.
- D. Stainless Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, ASTM F593 (ASTM F738M); with hex nuts, ASTM F594 (ASTM F836M); and, where indicated, flat washers; Alloy Group 1 (A1).
- E. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563 (ASTM A563M); 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: 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 in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.
- G. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329/F2329M.
- 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 B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
- I. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches (41 by 22 mm) by length indicated with anchor straps or studs not less than 3 inches (75 mm) long at not more than 8 inches (200 mm) o.c. Provide with temporary filler and tee-

head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B633, 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 D1187/D1187M.
- C. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, non-staining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. 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 (20 MPa).

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 (1 mm) 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 (3.2 by 38 mm)**, with a minimum **6-inch (150-mm)** embedment and **2-inch (50-mm)** hook, not less than **8 inches (200 mm)** from ends and corners of units and **24 inches (600 mm)** 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. Fabricate supports for operable partitions from continuous steel beams of sizes recommended by partition manufacturer with attached bearing plates, anchors, and braces as recommended by partition manufacturer. Drill or punch bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition Shop Drawings.
- D. Galvanize miscellaneous framing and supports where indicated.
- E. Prime miscellaneous framing and supports with zinc-rich primer 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 (19-mm)** bolts, spaced not more than **6 inches (150 mm)** from ends and **24 inches (600 mm)** 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 (50 mm)** 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 METAL LADDERS

- A. Steel Ladders:
1. Space siderails **18 inches (457 mm)** apart unless otherwise indicated.
 2. Siderails: Continuous, **1/2-by-2-1/2-inch (12.7-by-64-mm)** steel flat bars, with eased edges.
 3. Rungs: **1-inch- (25-mm-)** diameter steel bars.
 4. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
 5. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
 6. Source Limitations: Obtain nonslip surfaces from single source from single manufacturer.

7. Provide platforms as indicated fabricated from welded or pressure-locked steel bar grating, supported by steel angles. Limit openings in gratings to no more than [1/2 inch (12 mm)] in least dimension.
8. Support each ladder at top and bottom and not more than 60 inches (1500 mm) o.c. with welded or bolted steel brackets.
9. Galvanize and prime exterior ladders, including brackets.

2.9 LADDER SAFETY CAGES

A. General:

1. Fabricate ladder safety cages to comply with ANSI A14.3. Assemble by welding or with stainless steel fasteners.
2. Provide primary hoops at tops and bottoms of cages and spaced not more than 20 feet (6 m) o.c. Provide secondary intermediate hoops spaced not more than 48 inches (1200 mm) o.c. between primary hoops.
3. Fasten assembled safety cage to ladder rails and adjacent construction by welding or with stainless steel fasteners unless otherwise indicated.

B. Steel Ladder Safety Cages:

1. Primary Hoops: 1/4-by-4-inch (6.4-by-100-mm) flat bar hoops.
2. Secondary Intermediate Hoops: 1/4-by-2-inch (6.4-by-50-mm) flat bar hoops.
3. Vertical Bars: 3/16-by-1-1/2-inch (4.8-by-38-mm) flat bars secured to each hoop.
4. Galvanize and prime ladder safety cages, including brackets and fasteners.

2.10 STRUCTURAL-STEEL DOOR FRAMES

- A. Fabricate structural-steel door frames from steel shapes, plates, and bars of size and to dimensions indicated, fully welded together, with 5/8-by-1-1/2-inch (16-by-38-mm) steel channel stops, unless otherwise indicated. Plug-weld built-up members and continuously weld exposed joints. Secure removable stops to frame with countersunk machine screws, uniformly spaced at not more than 10 inches (250 mm) o.c. Reinforce frames and drill and tap as necessary to accept finish hardware.

1. Provide with integrally welded steel strap anchors for securing door frames into adjoining concrete or masonry.

- B. Extend bottom of frames to floor elevation indicated with steel angle clips welded to frames for anchoring frame to floor with expansion shields and bolts.

- C. Galvanize and prime exterior steel frames.

- D. Prime steel frames with primer specified in Section 099600 "High-Performance Coatings."

2.11 METAL BOLLARDS

- A. Fabricate metal bollards from Schedule 40 steel pipe.

- B. Fabricate sleeves for bollard anchorage from steel or stainless steel pipe with 1/4-inch- (6.4-mm-) thick, steel or stainless steel plate welded to bottom of sleeve. Make sleeves not less than 8 inches (200 mm) deep and 3/4 inch (19 mm) larger than OD of bollard.

- C. Prime steel bollards with primer specified in Section 099600 "High-Performance Coatings."

2.12 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. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span, but not less than 8 inches (200 mm) unless otherwise indicated.
- C. Galvanize and prime loose steel lintels located in exterior walls.

2.13 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.

2.14 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.

2.15 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M 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 galvanized surfaces 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 unless primers specified in Section 099600 "High-Performance Coatings" are indicated.
- 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. 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."
- 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.

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 supports for operable partitions securely to, and rigidly brace from, building structure.
- C. Anchor shelf angles securely to existing construction with expansion anchors.
- D. 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.
- E. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installation of Bearing and Leveling Plates" Article.
 - 1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.3 INSTALLATION OF METAL BOLLARDS

- A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.
 - 1. Do not fill removable bollards with concrete.

- B. Anchor bollards in concrete in formed or core-drilled holes not less than 8 inches (1050 mm) deep and 3/4 inch (19 mm) larger than OD of bollard. Fill annular space around bollard solidly with non-shrink grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch (3 mm) toward bollard.

- C. Fill bollards solidly with concrete, mounding top surface to shed water.

- 1. Do not fill removable bollards with concrete.

3.4 INSTALLATION OF PIPE GUARDS

- A. Provide pipe guards at exposed vertical pipes in at locations indicated on Drawings where not protected by curbs or other barriers. Install by bolting to wall or column with expansion anchors. Provide four 3/4-inch (19-mm) bolts at each pipe guard. Mount pipe guards with top edge 26 inches (660 mm) above driving surface.

3.5 INSTALLATION OF 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 shrinkage-resistant grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.6 REPAIRS

- A. Touchup Painting:
 - 1. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099113 "Exterior Painting."
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION

**SECTION 05 50 00.01 - METAL FABRICATIONS - BURN BUILDING, TRAINING TOWER,
AND DRAFTING PIT**

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 metal fabrications:
 - 1. Rough hardware.
 - 2. Steel stairs.
 - 3. Steel pipe handrails attached to steel stairs.
 - 4. Steel pipe handrails attached to walls adjacent to stairs.
 - 5. Steel pipe guardrails.
 - 6. Steel grating.
 - 7. Steel components and hardware for doors and windows.
 - 8. Miscellaneous steel items.

1.3 SUBMITTALS

- A. General: Submit each item in this Article according to the General Conditions of the Contract and Division 1 Specification Sections.
- B. Product data for steel shapes and plates, steel grating and treads, paint products, and grout.
- C. Shop drawings detailing fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.
- D. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.

1.4 QUALITY ASSURANCE

- A. Fabricator Qualifications: Firm experienced in producing metal fabrications similar to those indicated for this Project with a record of successful in-service performance, and with sufficient production capacity to produce required units without delaying the Work.
- B. Installer Qualifications: Engage an experienced Installer who has completed steel work similar in material and extent to that indicated for this Project and with a record of successful in-service performance.

- C. Welding Standards: Comply with applicable provisions of AWS D1.1 "Structural Welding Code--Steel," AWS D1.2 "Structural Welding Code--Aluminum," and AWS D1.3 "Structural Welding Code--Sheet Steel."

- 1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

- D. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Division 1 Section "Project Management and Coordination".

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver structural steel to Project site in such quantities and at such times to ensure continuity of installation.
- B. Store materials to permit easy access for inspection and identification. Keep steel members off ground by using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration.

PART 2 - PRODUCTS

2.1 FERROUS METALS

- A. Metal Surfaces, General: For metal fabrications exposed to view in the completed Work, provide materials selected for their surface flatness, smoothness, and freedom from surface blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- B. Steel Wide Flange Shapes: ASTM A 992.
 - 1. Galvanized finish unless otherwise indicated.
- C. Steel Channels: ASTM A 572.
 - 1. Galvanized finish unless otherwise indicated.
- D. Steel Angles, Plates, and Bars: ASTM A 36.
 - 1. Galvanized finish unless otherwise indicated.
- E. Steel Tubing: Cold-Formed Steel Tubing: ASTM A 500, Grade B.
 - 1. Galvanized finish unless otherwise indicated.
- F. Steel Pipe: ASTM A 53, standard weight (schedule 40), unless otherwise indicated, or another weight required by structural loads.
 - 1. Galvanized finish unless otherwise indicated.

- G. Steel Grating: 2" deep, 13 gauge, galvanized 'Perf-O Grip' grating by Cooper B-Line or an approved equivalent, subject to compliance with requirements, by the following manufacturers:
 - 1. Metalex
 - 2. Nucor Grating
 - a. Galvanized finish unless otherwise indicated.
- H. Steel Stair Treads: 2" deep, 13 gauge, galvanized 'Perf-O Grip' stair treads by Cooper B-Line or an approved equivalent, subject to compliance with requirements, by the following manufacturers:
 - 1. Metalex
 - 2. Nucor Grating
 - a. Galvanized finish unless otherwise indicated.
- I. Stainless Steel: Grade and type designated below for each form required:
 - 1. Tubing: ASTM A 554, Grade MT 316.
 - 2. Pipe: ASTM A 312, Grade TP 316.
 - 3. Castings: ASTM A 743, Grade CF 8M.
 - 4. Plate: ASTM A240, Type 316.
 - 5. Bolts: ASTM F593, Group 2 with ASTM F594 hex nuts and washers, all type 316.
- J. Cor-ten Steel: USS Cor-ten A
 - 1. Plates & Shapes: ASTM A-588
- K. Gray-Iron Castings: ASTM A 48, Class 30.
- L. Malleable-Iron Castings: ASTM A 47, Grade 32510.
- M. Welding Rods and Bare Electrodes: Select according to AWS specifications for the metal alloy to be welded.

2.2 PAINT

- A. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements of FS TT-P-664, selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.
- B. Finish Paint: Exterior quality, rust-inhibiting enamel paint. Consult Owner for color.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in galvanized steel, with dry film containing not less than 94 percent zinc dust by weight, and complying with MIL-P-21035 or SSPC-Paint 20.

2.3 FASTENERS

- A. General: Provide plated fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating. Select fasteners for the type, grade, and class required.
- B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A, with hex nuts, ASTM A 563, and, where indicated, flat washers.
- C. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy hex steel structural bolts, heavy hex carbon-steel nuts, and hardened carbon-steel washers.
 - 1. Finish: Hot-dip zinc-coating, ASTM A 153, Class C.
- D. Anchor Bolts: ASTM F 1554, Grade 36.
 - 1. Provide threaded carbon-steel hooked bolts and carbon-steel nuts; and flat hardened-steel washers zinc-coated by hot-dip process according to ASTM A 153, Class C or mechanically deposited according to ASTM B 695, Class 50 where item being fastened is indicated to be galvanized.
- E. Machine Screws: ASME B18.6.3.
- F. Lag Bolts: ASME B18.2.1.
- G. Wood Screws: Flat head, carbon steel, ANSI B18.6.1.
- H. Plain Washers: Round, carbon steel, ANSI B18.21.1.
- I. Lock Washers: Helical, spring type, carbon steel, ANSI B18.21.1.
- J. Expansion Anchors: Stud type with a single piece three section wedge. The anchors shall meet the description in Federal Specification A-A-1923A, Type 4. Anchors shall be Hilti Kwik Bolt 3, manufactured by Hilti Fastening Systems, or an approved equivalent by ITW Ramset/Redhead or Powers Fasteners, Inc.
 - 1. Material: Carbon steel components zinc plated to comply with ASTM B633, service condition SC 1, Type III.
 - 2. Material: Where indicated as stainless steel, Group 1 alloy 304 or Group 2 alloy 316 stainless-steel bolts and nuts complying with ASTM F 593 and ASTM F 594.
- K. Sleeve anchors shall be specifically manufactured for use in hollow CMU, with expansion sleeves, spacer sleeves, and hex nut. Anchors shall be Hilti HLC-HX SS 304, manufactured by Hilti Fastening Systems, or an approved equivalent by ITW Ramset/Redhead or Powers Fasteners, Inc.
 - 1. Material: Where indicated as stainless steel, Group 1 alloy 304 or Group 2 alloy 316 stainless-steel bolts and nuts complying with ASTM F 593 and ASTM F 594.
- L. Adhesive Anchors:
 - 1. Material: Group 1 alloy 304 or Group 2 alloy 316 stainless-steel bolts and nuts complying with ASTM F 593 and ASTM F 594.

2. Where installed in hollow CMU, adhesive anchors shall consist of a threaded anchor rod, nut, and washer, a cylindrical wire mesh screen tube, and an injectable adhesive material specifically designed for fastening into material containing voids and holes such as hollow block. Adhesive anchors shall be Hilti HIT-HY 270, manufactured by Hilti Fastening Systems, or an approved equivalent by ITW Ramset/Redhead or Powers Fasteners, Inc.
3. Where installed in grouted CMU, adhesive anchors shall consist of a threaded anchor rod and an injectable adhesive material specifically designed for fastening into solid masonry and/or grouted masonry cells. Adhesive anchors shall be Hilti HIT-HY 270, manufactured by Hilti Fastening Systems, or an approved equivalent by ITW Ramset/Redhead or Powers Fasteners, Inc.
4. Where installed in concrete, adhesive anchors shall consist of a threaded anchor rod and an injectable adhesive material specifically designed for fastening into cracked or uncracked concrete. Adhesive anchors shall be Hilti HIT-HY 200, manufactured by Hilti Fastening Systems, or an approved equivalent by ITW Ramset/Redhead or Powers Fasteners, Inc.

2.4 GROUT

- A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for exterior applications.
- B. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include the following:
 1. Nonshrink, Nonmetallic Grouts:
 - a. Euco N-S Grout; Euclid Chemical Co.
 - b. Five Star Grout; Five Star Products.
 - c. Masterflow 928 and 713; Master Builders Technologies, Inc.

2.5 FABRICATION, GENERAL

- A. Form metal fabrications from materials of size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of each metal fabrication.
- B. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.
- C. Shear and punch metals cleanly and accurately. Remove burrs.
- D. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- E. Remove sharp or rough areas on exposed traffic surfaces.

- F. 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 that no roughness shows after finishing, and contour of welded surface matches those adjacent.
- G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.
- H. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- I. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. 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.
- J. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- K. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

2.6 FABRICATION OF STEEL PIPE GUARDRAILS, HANDRAILS, AND RAILING SYSTEMS

- A. General: Fabricate pipe guardrails, handrails, and railing systems to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of pipe, post spacings, and anchorage, but not less than that required to support structural loads.
- B. Interconnect railing and guardrail and handrail members by butt-welding or welding with internal connectors, at fabricator's option, unless otherwise indicated.
1. At tee and cross intersections, cope ends of intersecting members to fit contour of pipe to which end is joined, and weld all around.
- C. Form changes in direction of guardrails, handrails, and rails as follows:
1. By welding in prefabricated flush elbow fittings.
 2. By radius bends of radius indicated.
 3. By flush radius bends.
 4. By bending and mitering elbow bends.
 5. By any method indicated above, applicable to change of direction involved.
- D. Form simple and compound curves by bending pipe in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of pipe throughout

entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of pipe.

- E. Welded Connections: Fabricate guardrails, handrails, and railing systems for connection of members by welding. For connections made during fabrication, 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 tee and cross intersections, cope ends of intersecting members to fit contour of pipe or tube to which end is joined, and weld all around.
 - 5. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
- F. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated.
- G. Close exposed ends of pipe by welding steel plate in place.
- H. Brackets, Flanges, and Fittings: Provide manufacturer's heavy duty wall brackets, end closures, flanges, and miscellaneous fittings for interconnections of pipe and attachment of guardrails, handrails, and railing systems to other work..
- I. Connect railing posts to steel stair framing and steel platform framing by direct welding, unless otherwise indicated.
- J. For galvanized guardrails, handrails, and railing systems, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous components unless otherwise indicated.

2.7 STEEL AND IRON FINISHES

- A. Galvanizing: For those items indicated for galvanizing, apply zinc coating by the hot-dip process complying with the following requirements:
 - 1. ASTM A 153 for galvanizing iron and steel hardware.
 - 2. ASTM A 123 for galvanizing both fabricated and unfabricated iron and steel products made of uncoated rolled, pressed, and forged shapes, plates, bars, and strip 0.0299 inch thick or thicker.
- B. Galvanizing Vent Hole Plugs: At galvanizing vent holes in pipes and tubes at railings, steel stairs, rope frames and other noted items, plug all holes after galvanizing and installation are complete in one of the following ways: Hammer in a zinc galvanizing vent hole plug by Bruce Reichelt Enterprises (503) 879-9085, grind it smooth, and touch up with galvanizing repair paint. A second option is to plug the holes with a black nylon bumper panel retainer by Au-ve-co Products (Part number 10831) and supplied by Fastenal (Fastenal part number 0162595 at www.fastenal.com), or an approved equivalent. Provide a different size plug if galvanizing vent hole is different size than the specified plug. A third option is to plug weld the vent holes after galvanizing, grind the welds smooth, and touch up with galvanizing repair paint.

- C. Preparation for Shop Priming: Prepare uncoated ferrous metal surfaces to comply with minimum requirements for SSPC-SP6, "Commercial Blast Cleaning" for surface preparation specifications and environmental exposure conditions of installed metal fabrications.
- D. Apply shop primer to uncoated surfaces of metal fabrications indicated to be painted. Comply with requirements of SSPC-PA 1 "Paint Application Specification No. 1" for shop painting.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installing anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.2 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction. Include expansion anchors, sleeve anchors, adhesive anchors, through-bolts, and other connectors as required.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing miscellaneous metal fabrications. Set metal fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete masonry or similar construction.
- D. 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 the surfaces of exterior units that have been hot-dip galvanized after fabrication and are intended for bolted or screwed field connections.
- E. 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 that no roughness shows after finishing, and contour of welded surface matches those adjacent.
- F. Secure stair treads to steel stringers with bolts.

3.3 INSTALLATION OF STEEL PIPE GUARDRAILS, HANDRAILS, AND RAILINGS

- A. Fit exposed connections accurately together to form tight, hairline joints.

- B. Adjust guardrails, handrails, and railing systems prior to anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated. Plumb posts in each direction.
 - 1. Set posts plumb within a tolerance of 1/4 inch in 12 feet.
 - 2. Align rails so that variations from level for horizontal members and from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.
- C. Use fully welded joints for permanently connecting railing components by welding. Cope or butt components to provide 100 percent contact, or use fittings designed for this purpose.
- D. Secure handrails to wall with wall brackets and end fittings. Provide bracket with indicated clearance from inside face of handrail and finished wall surface. Locate brackets at spacing required to support structural loads, but at no greater spacing than that indicated. Secure wall brackets and wall return fittings to building construction using type of bracket with predrilled hole for exposed bolt anchorage.
- E. Anchor handrails to masonry walls with through bolts, as shown on the drawings.
- F. Anchor railing posts to concrete slabs and handrails to concrete walls with expansion anchors, as shown on the drawings.
- G. Connect railing posts to steel stair framing and steel platform framing by direct welding, unless otherwise indicated.

3.4 SETTING BASE PLATES

- A. Clean concrete bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of base plates.
- B. Set base plates on wedges or other adjustable devices. After the bearing members have been positioned and plumbed, tighten the anchor bolts. Do not remove wedges or shims, but if protruding, cut off flush with the edge of the base plate before packing with grout.
 - 1. Use nonshrink, nonmetallic grout, unless otherwise indicated.
 - 2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.5 PLUGGING GALVANIZING VENT HOLES AFTER INSTALLATION

- A. After installation, plug galvanizing vent holes in pipes and tubes at railings, steel stairs, rope frames and other noted items as indicated in Part 2 of this specification section.

3.6 FIELD QUALITY CONTROL

- A. Owner will engage an independent testing and inspecting agency to perform field inspections and tests and to prepare test reports.
 - 1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from requirements.

- B. Correct deficiencies in or remove and replace structural steel that inspections and test reports indicate do not comply with specified requirements.
- C. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.
- D. Field-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- E. All welds shall be visually inspected. If required as a result of visual inspection, welded connections shall be inspected and tested according to AWS D1.1 and the inspection procedures listed below, at testing agency's option.
 - 1. Liquid Penetrant Inspection: ASTM E 165.
 - 2. 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.
 - 3. Radiographic Inspection: ASTM E 94 and ASTM E 142; minimum quality level "2-2T."
 - 4. Ultrasonic Inspection: ASTM E 164.
- F. Testing and inspections of rope tie-off points:
 - 1. Test each rope anchor assembly and rope frame assembly with a 5,000-pound pull test, as follows:
 - a. Surface-mounted rope anchor assembly: pull test on hoist ring perpendicular to the slab or wall surface on which assembly is attached.
 - 2. Embedded (through-slab) rope anchor assembly: pull test on round bar perpendicular to the slab surface.
 - 3. Rope frame assembly: pull test at top of frame at each corner of frame perpendicular to slab surface, testing one corner at a time.
 - 2. Inspect gantry assembly as follows:
 - a. Visually inspect all bolted connections, including bolts into/through slab.
 - b. Visually inspect all welds.
 - c. Visually inspect all hoist ring connections to steel framing.

3.7 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop and finish paint, and paint exposed areas with one coat of same material as used for shop painting to comply and two coats of finish paint.
- B. For galvanized surfaces, clean welds, bolted connections, and abraded areas, and apply galvanizing repair paint to comply with ASTM A 780.

END OF SECTION 05 50 00.01

DSECTION 061053 - MISCELLANEOUS 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 (38 mm actual) size in least dimension.
- B. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater size but less than 5 inches nominal (114 mm actual) 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 D5664.
 - 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. Evaluation Reports: For the following, from ICC-ES:
 - 1. 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 lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber 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, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded 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 MATERIALS

- 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. Do not use inorganic boron (SBX) for sill plates.
 - 2. For exposed items indicated to receive a stained or natural finish, chemical formulations shall not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or 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 the following:
 - 1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.

2.3 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 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 (3.2 m) 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 D2898. 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 D3201 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 D5664, and design value adjustment factors shall be calculated according to ASTM D6841.
- C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.
- D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.
- E. Application: Treat all miscellaneous 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 (19-mm) nominal thickness.

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. Where 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 A153/A153M.
 - B. Nails, Brads, and Staples: ASTM F1667.
 - C. Screws for Fastening to Metal Framing: ASTM C1002 or ASTM C954, 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 A653/A653M, **G60 (Z180)** coating designation.
 1. Use for interior locations unless otherwise indicated.
 - B. Hot-Dip, Heavy-Galvanized Steel Sheet: ASTM A653/A653M; 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 (Z550)** coating designation; and not less than **0.036 inch (0.9 mm)** thick.
 1. Use for wood-preservative-treated lumber 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 (0.6 mm)**.

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 carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit 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 (406 mm)** o.c.

- G. 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.
- H. Comply with AWPAC 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.
- I. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- J. Securely attach 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.
 - 2. ICC-ES evaluation report for fastener.
- K. 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 INSTALLATION OF WOOD BLOCKING AND NAILER

- A. Install where indicated and where required for 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.

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 miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION

SECTION 061600 - SHEATHING

PART 1 - GENERAL

1.1 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.

1.2 ACTION SUBMITTALS

- A. Product Data:
 - 1. Roof sheathing.
 - 2. Composite nail base insulated roof sheathing.
 - 3. Sheathing joint-and-penetration treatment materials.
- 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.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, including list of ABAA-certified installers and supervisors employed by Installer, who work on Project.

PART 2 - PRODUCTS

2.1 WOOD PANEL PRODUCTS

- A. Emissions: Products are to 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.

2.2 ROOF SHEATHING

- A. Plywood Sheathing, Roofs: Either DOC PS 1 or DOC PS 2, Exposure 1 sheathing.
 - 1. Nominal Thickness: As indicated.

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 roof parapet and wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.
- 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.

SECTION 07 00 01 - THERMAL LINING SYSTEM - BURN BUILDING

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 requirements for the thermal lining system.

1.3 COMPONENT REQUIREMENTS FOR THERMAL LINING SYSTEM

- A. Provide thermal lining system that includes the following minimum components:
 - 1. A 1-inch thick layer of calcium silicate insulation with a maximum density of 18 pounds per cubic foot and a continuous service temperature rating of a minimum of 1,800° F. Provide material with a minimum compressive strength of 450 psi and minimum flexural strength of 260 psi. Provide material with maximum shrinkage of 1% in length and width when subjected to continuous temperature of minimum 1,700° F for 24 hours. Provide material with maximum "k" value of 0.73 at 800° F. Provide materials that are free of asbestos or any other toxic substances.
 - 2. Fully cover the insulation with thermo-ceramic refractory concrete fire castings. Provide castings that each measure 12" x 12" x 1-3/4" thick.
 - 3. Provide castings that interlock with one another in a fashion that ensures shedding of water from fire hose streams and preventing water from reaching the insulation barrier. Design castings to allow the installed system to immediately expand and contract with extreme fluctuations in temperatures associated with live fire training conducted in accordance with the latest edition of NFPA 1403, and as a result of the thermal shock generated by fire suppression using fire hose streams. Provide special shapes of castings to adapt the thermal lining system to different conditions, such as corner conditions at beams, columns, and wall openings. Provide bullnose corner castings or cast-in-place refractory material creating a chamfer, where the corners are subject to abuse from equipment, as indicated in the Contract Documents. Provide a completed system in which every casting interlocks with adjacent castings, providing an impenetrable, floating barrier of thermo-ceramic refractory concrete that fully covers and protects the insulation barrier, including ceiling panels, wall panels, and corners. Provide special castings to accommodate temperature monitoring devices, conduit, and wiring as indicated in the Contract Documents. Provide casting material with a density of 140 to 150 pounds per cubic foot and cold crushing strength of 10,000 psi after exposure to 2,000° F. Provide casting material that expels any absorbed water without cracking or spalling when exposed to temperatures up to 2,000° F.
 - 4. Anchor each casting to the structure with a minimum of one Grade 304 stainless steel anchor.

- a. For concrete substrates, provide expansion anchors that are a minimum 3/8" diameter, with 2" minimum embedment into concrete (or per the anchor manufacturer's recommendations, whichever is greater). Provide anchors that have a minimum pullout (tension) rating of 2,240 pounds in 4,000 psi concrete.
 - b. For concrete unit masonry substrates, provide anchors that are a minimum 3/8" diameter, with minimum 1-1/4" embedment into masonry (or per the anchor manufacturer's recommendations, whichever is greater). Provide anchors with a minimum pullout (tension) rating of 1,160 pounds in hollow core concrete masonry units.
5. Provide a base course of mortared-in-place fire brick for all wall locations that receive the thermal lining system down to floor level. Provide fire brick that is a minimum of 4-1/2" x 9" x 2-1/2" thick medium duty fire brick per ASTM C-27, set in type N Portland cement mortar.
 6. Provide stainless steel and aluminum flashings as indicated in the Contract Documents. For stainless steel flashings, provide Grade 304 stainless steel with a minimum thickness of .018". For aluminum flashings, provide a minimum thickness of .032".
 7. Provide refractory packings as indicated in the Contract Documents. Provide a general purpose castable packing mix for use to temperatures to 2,000°F. Provide packing mix that has good resistance to abrasion, a low iron content, no more than 0.5% shrinkage when exposed to 2,000° F, and minimum cold crushing strength of 1,400 psi after exposure to 2,000° F.

1.4 PERFORMANCE REQUIREMENTS FOR THERMAL LINING SYSTEM

- A. Provide thermal lining system that is specifically designed for use within live fire training structures (burn buildings) exposed to frequent training with Class A fuels. Provide a thermal lining system that is designed to withstand repetitive live fire training for 20 years without significant panel/tile replacement and without degradation of the thermal protection.
- B. Thermal lining shall provide thermal protection for the structural components from temperatures attained during fire training.
 1. Provide a thermal lining system that withstands temperatures at the exposed face of thermal lining during a live fire training evolution of up to 2,000° F.
 2. Provide a thermal lining system that keeps temperature behind the system during live fire training, at the face of the protected structure, below 350° F when the room temperature at the exposed face of the thermal lining system is 2,000°F.
 3. During a live fire training day, multiple live fire training evolutions may occur. After each evolution, the fire may be left smoldering, but not completely extinguished. At the beginning of the next evolution, the fire is reignited. This cycle typically repeats all day during a training day. As a result, significant residual heat builds up in the training structure by the last training evolution. Provide thermal lining system that withstands, without damage, residual heat buildup created by a minimum of 20 consecutive live fire training evolutions.
- C. Provide a thermal lining system that withstands, without damage, repetitive thermal shock created by rapid cooling of heated surfaces with cool water from water mains. Provide a thermal lining system that allows for expansion and contraction caused by rapid heating and cooling.

- D. Provide a thermal lining system that withstands, without damage, impact loads and other associated stresses induced by pressurized water sprayed from hoses (300 gallons per minute, 100 pounds per square inch of pressure) and thermally pressurized steam.
 - 1. Provide a thermal lining system that prevents water and steam penetration to the protected structure.
 - 2. Provide a thermal lining system that allows for the fact that almost all cementitious materials will absorb water through direct water application or through condensation caused by large fluctuations in temperature, such as those commonly experienced during winter months. Once this absorbed water is abruptly heated during a fire, it will convert to pressurized steam which could act to degrade the lining material. Provide a thermal lining system that expels water and vapor that could penetrate the system. Provide a thermal lining system that is functional in all seasons of the year.
 - 3. For multi-component thermal lining systems consisting of an insulation layer protected by another layer of durable materials, provide an insulation layer that does not sag or move behind the protective layer.
- E. Provide a thermal lining system that withstands, without damage, routine physical abuse during typical live fire training evolutions, including, but not limited to:
 - 1. impact of fire fighters' protective clothing, self-contained breathing apparatuses, or hand tools.
 - 2. impact of wood pallets or other Class A fuel materials "tossed" onto the fire and impacting the thermal lining system.
- F. Provide a thermal lining system that is functional year-round, withstanding the effects of seasonal weather considerations, including seasonal temperature changes, freeze/thaw cycles, humidity, and precipitation.
- G. Provide a thermal lining system that withstands, without damage, the effects of oxygen deficient atmosphere.
- H. Provide a thermal lining system that allows for the use of surface and subsurface mounted thermocouples that penetrate the lining.
- I. Provide a thermal lining system that is free from asbestos or other harmful ingredients, and shall not produce toxic byproducts during live fire training.
- J. Provide a thermal lining system that has properties that do not degrade under repeated use.
- K. Provide a thermal lining system that is capable of bracing tops of walls against lateral, out-of-plane movement, as shown on the drawings; or the thermal lining system manufacturer shall propose an acceptable (to be approved by the Engineer), alternate method for bracing tops of walls against lateral, out-of-plane movement while maintaining continuous thermal protection for the protected structural elements. Out of plane wind loads are stated on the drawings.

1.5 QUALIFICATION PROCEDURE

- A. For any prospective thermal lining system manufacturer/supplier/product that is not listed under Part 2, submit a written request for qualification to the Engineer. For all requests for qualification, include the information defined in the following sections and deliver to the Engineer 14 calendar days before the stated date of bid opening as identified in the solicitation documents. Lack of adequate information is sufficient cause for rejection. References to catalogs or other descriptive documents not included with the application for qualification to the Engineer are not acceptable.
- B. Manufacturer's Qualifications: Provide the following information:
 - 1. Corporate qualifications and capabilities that fully describe the ability to manufacture and provide the required thermal lining system and support to the Owner.
 - 2. A history of corporate experience manufacturing thermal lining systems for live fire training props ("burn buildings").
 - 3. A list of ten (10) completed projects in excess of 1,000 square feet, at least five (5) of which shall be more than ten (10) years old, illustrating thermal lining system performance equal or greater to the performance criteria listed in this specification. Include the award date, the completion date, the contract value, and the name and telephone number of a person employed by the Owner who has personal knowledge of the thermal lining system supplier's contractual and technical performance. Provide descriptions of any testing that has been performed on the product to indicate that it will have performance equal or greater to the performance criteria listed in this specification
- C. Installer's Qualifications: Provide the following information:
 - 1. Qualifications and capabilities that fully describe the ability to install the required thermal lining system.
 - 2. A history of experience installing thermal lining systems in live fire training props ("burn buildings").
 - 3. A list of ten (10) completed projects in excess of 1,000 square feet, at least five (5) of which shall be more than five (5) years old. Include the award date, the completion date, the contract value, and the name and telephone number of a person employed by the Owner who has personal knowledge of the thermal lining system's performance.

1.6 SUBMITTALS

- A. General: Submit each item in this Article according to the General Conditions of the Contract and Division 01 Specification Sections.
- B. Evidence of installer qualifications, including certification by the thermal lining system manufacturer.
- C. Certificate of Conformance: Manufacturer's certification that materials and equipment are physically and chemically compatible with each other, that materials are in compliance with performance requirements of this specification, and that each material and/or equipment is suitable for the intended purpose. Materials and equipment not listed in the certificate will not be permitted in the work area. Submit Material Safety Data Sheets (MSDS) for the thermal lining system.

- D. Materials Certification: Letter from the manufacturer certifying that materials shipped meet manufacturer's specification data.
- E. Samples of materials to be used, including thermal tile, insulation, flashing, anchoring system, and fire clay.
- F. Shop drawings detailing fabrication and erection of thermal lining system. Include plans, elevations, sections, and details of the thermal lining system and connections to substrates. Show anchorage and accessory items.
- G. Operations and Maintenance manual describing all required maintenance and operational requirements.

1.7 QUALITY ASSURANCE

- A. All thermal lining systems shall be provided by one manufacturer.
- B. Installer Qualifications: Install the thermal lining system by manufacturer or by a contractor approved by the manufacturer and under the supervision of the manufacturer.
- C. Warranties:
 - 1. The manufacturer shall furnish a five year warranty for the thermal lining system, starting from the date of Owner's acceptance of the Work, to cover replacement of all defective materials found within the warranty period.
 - 2. The installer shall furnish a one year warranty for the thermal lining system, starting from the date of Owner's acceptance of the Work, to cover replacement of all materials found to be defective due to workmanship found within the warranty period.
 - 3. Warranties can be limited to replacement of defective materials, including labor, due to thermal lining system components or performance. Warranties can exclude repairs, replacement, and corrective work to the substrate, structure, and/or property. Warranties can exclude mechanical damage due to abuse or neglect, structural failure, or forces of nature greater than normal weather conditions.
 - 4. Substrate shall be monolithic, without joints, holes, penetrations, or embedded items that pass through the entire thickness that could cause moisture to pass through the substrate into the thermal lining system, except for joints and items shown on the drawings. Warranty can exclude damage to the lining system and substrate caused by moisture penetration through the joints, holes, penetrations, and embedded items in the substrate that are not shown on the drawings.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver thermal lining system materials in manufacturer's original unopened containers or wrapped with labels intact and legible.
- B. Store and protect materials from damage and weather in accordance with the manufacturer's instructions. Keep materials clean and dry at all times.
- C. Handle materials in accordance with the manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 THERMAL LINING SYSTEM

- A. At noted locations in plans, provide HTL System 203, by High Temperature Linings, P.O. Box 1240, White Stone, Virginia 22578, Phone (800) 411-6313, www.firetrain.com, including all components and anchoring devices, or an approved equal.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean all surfaces to receive the thermal lining system of oils, dust, and other deleterious matter. Install the thermal lining system over dry surfaces.

3.2 INSTALLATION

- A. Install the thermal lining system and all accessories in accordance with the manufacturer's requirements.

3.3 CLEAN UP

- A. Remove all debris, scraps, containers, and any other trash resulting from the installation of the thermal lining system.

END OF SECTION 07 00 01

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.

- B. Related Requirements:

- 1. Section 075419 "Polyvinyl-Chloride (PVC) Roofing" for insulation specified as part of roofing construction.
 - 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 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.
- 2.3 ACCESSORIES
- A. 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."

3.6 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

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vertical-rib, snap-joint, standing-seam metal roof panels.
2. Roof insulation.
3. Underlayment.

B. Related Requirements:

1. Section 074293 "Soffit Panels" for metal panels used in horizontal soffit applications.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For standing-seam metal roof panels. 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 (1:10)**.
3. Submit Calculations with Registered Engineers Seal licensed in the state of North Carolina, verifying Roof Panel and attachment method resists wind pressures imposed on it pursuant to applicable Building Codes
4. Manufacturer's Technical Data Bulletins pertinent to the specifics of the Project and Roofing Assembly.

C. Samples for Initial Selection: Manufacturer's standard color charts, showing full range of available colors for each type of exposed finish.

1. Include similar Samples of trim and accessories involving color selection.

D. Samples for Verification: Actual sample of finished products for each type of exposed finish for metal panels and metal panel accessories.

1. Metal Panels: 12 inches (305 mm) long by actual panel width. Provide color chip verifying color selection.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For standing-seam metal roof panels, for tests performed by a qualified testing agency.
- B. Qualification Statements: For roof installers.
- C. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For metal panels.
- B. Manufacturer's Warranty: Executed copy of manufacturer's standard warranty.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Minimum five years of experience in manufacture of similar products in successful use in similar applications.
- B. Installer Qualifications: Experienced installer, certified by metal panel manufacturer, with minimum five of years of experience with successfully completed projects of a similar nature and scope..

1.6 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.

1.7 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed in accordance with manufacturers' written installation instructions and warranty requirements.

1.8 COORDINATION

- A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.
- B. 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.

1.9 WARRANTY

- A. Special Warranty: 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 metal and other materials beyond normal weathering.
 - 2. Warranty Period: Two years from date of Final Completion.
- B. Special Warranty on Panel Finishes: 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 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: 30 years from date of Final Completion.
- C. Special Weathertightness Warranty: Manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.
 - 1. Warranty Period: 10 years from date of Final Completion.

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 in accordance with ASTM E1592:
 - 1. Wind Loads: As indicated on Drawings.

2. Deflection Limits: For wind loads, no greater than **1/240** of the span.
 - B. Water Penetration under Static Pressure: No water penetration when tested in accordance with ASTM E1646 at the following test-pressure difference:
 1. Test-Pressure Difference: **6.24 lbf/sq. ft. (300 Pa)**.
 - 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 STANDING-SEAM METAL ROOF PANELS, GENERAL
- A. Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed fasteners in side laps. Include all accessories required for weathertight installation.
- 2.3 VERTICAL-RIB, SNAP-JOINT, STANDING-SEAM METAL ROOF PANELS
- A. Source Limitations: Obtain metal roof panel assembly and accessories from a single source with resources to provide fixed base roll forming, and accredited under IAS AC 472 Part B.
 - B. Subject to compliance with requirements, provide products from available manufacturers similar to but not limited to the Basis-of-Design:
 1. Sentriclad Kynar 500/Hylar 5000 coated Aluminum-Zinc Alloy (Galvalume): aluminum-zinc alloy-coated structural-steel sheet, ASTM A 792/A 792M, Class AZ50 coating designation, Grade 50 (Class AZM150 coating designation, Grade 275); 24 Gauge thick.
 - a. Finish: Manufacturer's standard fluoropolymer 2-coat system with topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2604].
 - C. Panels: Formed with vertical ribs at panel edges; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and snapping panels together.
 1. Structural Support: Over **solid deck**.
 2. Material: **Metallic-coated steel**
 3. Panel Profile: **Flat pan**
 4. Panel Coverage: **18 inches (457 mm)**.
 5. Panel Height: **1.75 inches (44 mm)**.
 6. Clips: designed to accommodate thermal movement.
 - a. Steel Clips: **0.064-inch- (1.63-mm-)** nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
 - b. Clip Spacing: **As indicated on approved Shop Drawings**.

2.4 ROOF INSULATION

A. Insulation over Solid Deck:

1. Polyisocyanurate Board Insulation: ASTM C1289, **Type II, Class 1, Grade 2** felt or glass-fiber mat facer on both major surfaces.
 - a. Compressive Strength: **20 psi (138 kPa)**.
 - b. Thickness:
 - 1) Base Layer: minimum **1-1/2 inches (38 mm)**
 - 2) Upper Layer: as indicated in drawings to achieve design R-value.

2.5 COVER BOARD

- A. Polyisocyanurate Insulation Cover Board: ASTM C1289 Type II, Class 4, Grade 1, **1/2 inch (13 mm)** thick, with a minimum compressive strength of **80 psi (551 kPa)**.

2.6 UNDERLAYMENT

- A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of **30 mils (0.76 mm)** thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.
1. Thermal Stability: Stable after testing at **240 deg F (116 deg C)**; ASTM D1970/D1970M.
 2. Low-Temperature Flexibility: Passes after testing at **minus 20 deg F (minus 29 deg C)**; ASTM D1970/D1970M.
 3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carlisle Residential; a division of Carlisle Construction Materials.
 - b. [Drexel Metals](#).
 - c. [GCP Applied Technologies Inc.](#)
 - d. [Henry Company](#).
 - e. [Kirsch Building Products, LLC](#).
 - f. [Owens Corning](#).
- B. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.

2.7 PANEL MATERIALS

- A. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with minimum ASTM A653/A653M, **G90 (Z275)** coating designation, or aluminum-zinc alloy-coated steel sheet complying with minimum ASTM A792/A792M, **Class AZ50 (Class AZM150)** coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

1. Nominal Thickness: [**0.022 inch (0.56 mm)**] [**0.028 inch (0.71 mm)**] [**0.034 inch (0.86 mm)**] [**0.040 inch (1.02 mm)**] [**0.052 inch (1.32 mm)**].
2. Surface: [**Smooth, flat**] [**Embossed**] finish.

2.8 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C645; cold-formed, metallic-coated steel sheet, minimum ASTM A653/A653M, **G90 (Z275)** hot-dip galvanized coating designation or ASTM A792/A792M, **Class AZ50 (Class AZM150)** coating designation. 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, fasteners, 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 ridges, 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- (25-mm-)** thick, flexible closure strips; cut or premolded 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, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.
- D. Gutters: Formed from same material as roof panels, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum **96-inch- (2400-mm-)** long sections, of size and metal thickness in accordance with manufacturer's recommendations. Furnish gutter supports spaced a maximum of **36 inches (914 mm)** o.c., fabricated from same metal as gutters. Provide wire ball strainers of compatible metal at outlets. Finish gutters to match **metal roof panels, roof fascia and rake trim**.
- E. Downspouts: Formed from same material as roof panels. Fabricate in **10 ft. (3 m)** long sections, complete with formed elbows and offsets, of size and metal thickness in accordance with manufacturer's recommendations. Finish downspouts to match gutters.
- F. Roof Curbs: Fabricated from same material as roof panels, **0.048-inch (1.2-mm)** nominal thickness; with bottom of skirt profiled to match roof panel profiles and with welded top box and integral full-length cricket. Fabricate curb subframing of **0.060-inch- (1.52-mm-)** nominal thickness, angle-, C-, or Z-shaped steel sheet. Fabricate curb and subframing to withstand indicated loads of size and height indicated. Finish roof curbs to match metal roof panels.
 1. Insulate roof curb with **1-inch- (25-mm-)** thick, rigid insulation.
- G. Panel Fasteners: Self-tapping screws designed to withstand design loads.

- H. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape **1/2 inch (13 mm)** wide and **1/8 inch (3 mm)** thick.
 2. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
 3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.9 FABRICATION

- A. 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. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- C. 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.
- D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations 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 other than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 3. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with manufacturer's recommendations.
 4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not permitted on faces of accessories exposed to view.
 5. 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 metal panel manufacturer for application, but not less than thickness of metal being secured.

2.10 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 unacceptable. 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: 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[**for seacoast and severe environments**].
 - 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 (0.013 mm)**.

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 solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof 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 subframing, furring, and other miscellaneous panel support members and anchorages in accordance with ASTM C754 and metal panel manufacturer's written installation instructions.

3.3 INSTALLATION OF ROOF INSULATION

- A. General: Install insulation concurrently with metal panel installation, in thickness indicated to cover entire surface, in accordance with manufacturer's written installation instructions.

1. Set vapor-retarder-faced units with vapor retarder toward warm side of construction unless otherwise indicated. Do not obstruct ventilation spaces except for firestopping.
2. Tape joints and ruptures in vapor retarder and seal each continuous area of insulation to the surrounding construction to ensure airtight installation.

3.4 INSTALLATION OF COVER BOARD

- A. Install cover board over insulation in accordance with manufacturer's written installation instructions. Install with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of **6 inches (152 mm)** in each direction.

3.5 INSTALLATION OF UNDERLAYMENT

- A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated **below**, wrinkle free, in shingle fashion to shed water, and with end laps of not less than **6 inches (152 mm)** staggered **24 inches (610 mm)** between courses. Overlap side edges not less than **3-1/2 inches (90 mm)**. Roll laps with roller. Cover underlayment within 14 days.
 1. Apply over the entire roof surface.
- B. Slip Sheet: Apply slip sheet over underlayment before installing metal roof panels.
- C. Flashings: Install flashings to cover underlayment to comply with requirements specified in Section 076200 "Sheet Metal Flashing and Trim."

3.6 INSTALLATION OF STANDING-SEAM METAL ROOF PANELS

- A. Install metal panels in accordance with manufacturer's written installation instructions and approved Shop Drawings in orientation, sizes, and locations 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. Concealed Clip, Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.
 1. Install clips to supports with self-tapping fasteners.
 2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
- E. Panel Joints: Fasten panel joints to substrate in accordance with manufacturer's instructions.
 1. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
 2. Watertight Installation:
 - a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommended in writing by manufacturer as needed to make panels watertight.
 - b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
 - c. At panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with sealant and fastened together by interlocking clamping plates.
- 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 panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal roof panel manufacturers; or, if not indicated, types recommended by metal roof panel manufacturer.
- G. Flashing and Trim: Comply with performance requirements and manufacturer's written installation instructions. Provide concealed 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 weather resistant.
 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 and weather-resistant performance.
 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 ft. (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of

intermeshing hooked flanges, not less than **1 inch (25 mm)** deep, filled with mastic sealant (concealed within joints).

- H. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than **36 inches (914 mm)** o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.
- I. Downspouts: Join sections with telescoping joints. Provide fasteners designed to hold downspouts securely **1 inch (25 mm)** away from walls; locate fasteners at top and bottom and at approximately **60 inches (1524 mm)** o.c. in between.
 - 1. Provide elbows at base of downspouts to direct water away from building.
- J. Roof Curbs: Install flashing around bases where they meet metal roof panels.
- K. Pipe and Conduit Penetrations: Fasten and seal to metal roof panels as recommended by manufacturer.

3.7 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align metal panel units within installed tolerance of **1/4 inch in 20 ft. (6 mm in 6 m)** on slope and location lines as indicated and within **1/8-inch (3-mm)** offset of adjoining faces and of alignment of matching profiles.

3.8 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect metal roof panel installation, including accessories. Report results in writing.
- B. Remove and replace applications of metal roof panels where tests and inspections indicate that they do not comply with specified requirements.
- C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.
- D. Prepare test and inspection reports.

3.9 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. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074113.16

SECTION 074293 - SOFFIT 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. Metal soffit panels.

- B. Related Sections:

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 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 flashing, trim, and anchorage systems, at a scale of not less than **1-1/2 inches per 12 inches (1:10)**.
- C. Samples for Initial Selection: For each type of metal 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 Panels: **12 inches (305 mm)** 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, tests performed by a qualified testing agency.
- C. 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. 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.

1.8 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.

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 walls, 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 Substantial Completion.
- 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 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 Substantial Completion.

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 E1592:
 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 E283 at the following test-pressure difference:
 1. Test-Pressure Difference: **1.57 lbf/sq. ft.**
- C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E331 at the following test-pressure difference:
 1. Test-Pressure Difference: **2.86 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 (67 deg C)**, ambient; **180 deg F (100 deg C)**, material surfaces

2.2 METAL SOFFIT PANELS

- A. Provide metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners in side laps. Include accessories required for weathertight installation.
- B. Flush-Profile Metal Soffit Panels: **Solid** panels formed with vertical panel edges and **intermediate stiffening ribs symmetrically spaced** between panel edges; with flush joint between panels.
 1. Subject to compliance with requirements, provide products from available manufacturers similar to but not limited to the Basis-of-Design:
 - a. Basis of Design: FP 100 1" Interlocking Flush Panel by Sentrigard
 2. Material: Same material, finish, and color as metal **roof** panels.
 3. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, **G90 (Z275)** coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, **Class AZ50 (Class AZM150)** coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

- a. Nominal Thickness: **0.022 inch (0.56 mm)**.
- b. Exterior Finish: **Two-coat fluoropolymer**
- c. Color: Match roof panels

2.3 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Sub-framing and Furring: ASTM C645, cold-formed, metallic-coated steel sheet, ASTM A653/A653M, **G90 (Z275 hot-dip galvanized)** coating designation or ASTM A792/A792M, **Class AZ50 (Class AZM150)** 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, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
 1. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum **1-inch (25-mm)** 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. Finish flashing and trim with same finish system as adjacent metal panels.
- D. Panel Fasteners: Self-tapping screws designed to withstand design loads.
- E. Panel Sealants: Provide sealant types recommended by manufacturer that are compatible with panel materials, are non-staining, and do not damage panel finish.
 1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray 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.
 2. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
 3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.4 FABRICATION

- A. 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 soffit 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. Two-Coat Fluoropolymer: AAMA 2605. 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.

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 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 panel manufacturer.
 2. Examine sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal panel manufacturer.
 - a. Verify that air- or water-resistive barriers 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 C754 and metal panel manufacturer's written recommendations.
1. Soffit Framing: Wire tie or clip furring channels to supports, as required to comply with requirements for assemblies indicated.

3.3 INSTALLATION

- A. 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. 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. 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.
- E. Watertight Installation:
1. Apply a continuous ribbon of sealant or tape to seal lapped joints of metal panels, using sealant or tape as recommend by manufacturer on side laps of nesting-type panels and elsewhere as needed to make panels watertight.
 2. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
 3. At panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with sealant and fastened together by interlocking clamping plates.

- 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 panel system including trim, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal panel manufacturer; or, if not indicated, provide types recommended by metal 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 achieve waterproof performance.
 - 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

3.4 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

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.

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 Substantial Completion.

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 [NRCA's "The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control, and Reroofing"] [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 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. 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] <Insert size requirement>.
- 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

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. Non-staining silicone joint sealants.
 - 2. Mildew-resistant joint sealants.
 - 3. Joint-sealant backing.

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. Qualification Data: For qualified testing agency.
- B. Product Test Reports: For each kind of joint sealant, for tests performed by manufacturer and witnessed by a qualified testing agency.
- C. 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 C1021 to conduct the testing indicated.

- C. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.7 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.

1.8 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 Substantial Completion.

- 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 Substantial Completion.

- 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 NONSTAINING SILICONE JOINT SEALANTS

- A. Non-staining Joint Sealants: No staining of substrates when tested according to ASTM C1248.

- B. Silicone, Non-staining, S, NS, 100/50, NT: Non-staining, single-component, non-sag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Pecora Corporation.
 - b. Sika Corporation; Joint Sealants.
 - c. Tremco Incorporated.

2.3 MILDEW-RESISTANT JOINT SEALANTS

- A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.
- B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, non-sag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
1. 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. May National Associates, Inc.; a subsidiary of Sika Corporation.
 - d. Pecora Corporation.

2.4 JOINT-SEALANT BACKING

- A. Sealant Backing Material, General: Non-staining; 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. Adfast.
 - b. Alcot Plastics Ltd.
 - c. BASF Corporation.
- B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin), 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.

2.5 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: 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 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 C1193 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.
- F. Tooling of Non-sag 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 C1193 unless otherwise indicated.
 - 4. Provide recessed joint configuration of recess depth and at locations indicated on Drawings according to Figure 8C in ASTM C1193.
 - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

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 one test for each 1000 feet (300 m) of joint length thereafter or one test per each floor per elevation.
 - 2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.

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- 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 Substantial Completion. 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.

END OF SECTION

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. Exterior steel doors and frames.
- B. Related Requirements:
 - 1. Section 087100 "Door Hardware" for door hardware for hollow-metal doors.
 - 2. Section 055000.01 Metal Fabrications for door Training Structure & Burn Building assemblies as indicated on drawings

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.
 - 2. Third-Party Certifications: For each product.
 - 3. Third-Party Certified Life Cycle Assessment: For each product.
- 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 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. Maximum-Duty Doors and Frames: ANSI/SDI A250.8, Level 4; ANSI/SDI A250.4, Level A.
1. Doors:

- a. Type: As indicated in the Door and Frame Schedule on Drawings.
- b. Thickness: 1-3/4 inches (44.5 mm).
- c. Face: Metallic-coated steel sheet, minimum thickness of 0.067 inch (1.7 mm), with minimum **G90** coating.
- d. Edge Construction: Model 2, Seamless.
- e. Edge Bevel: Provide the 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: Vertical steel stiffener.
2. Frames:
 - a. Materials: Metallic-coated steel sheet, minimum thickness of 0.067 inch (1.7 mm), with minimum **G90** coating.
 - b. Construction: Full profile welded.
3. Exposed Finish: **Prime**

2.3 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.
- B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.
- C. 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.

2.4 MATERIALS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- C. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- D. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.
- E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
- F. 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.

- G. 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.
- H. Glazing: Comply with requirements in Section 088000 "Glazing."

2.5 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.

2.6 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.

2.7 LOUVERS

- a. Provide louvers for exterior doors, where indicated, that comply with SDI 111, with blades or baffles formed of 0.020-inch (0.5-mm-) thick, cold-rolled steel sheet set into 0.032-inch (0.8-mm-) thick steel frame. Provide corrosion-resistant materials to match door assembly.
 - 1) Sightproof Louver: Stationary louvers constructed with inverted-V or inverted-Y blades. Pierced louver with integral insect screen is acceptable.
 - 2) Provide insect screen with louver.
- b. Form corners of moldings with hairline joints. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.

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. Floor Anchors: Secure with post-installed expansion anchors.
 - 3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
 - 4. 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.
 - 5. 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.

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

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.
- B. Door hardware includes, but is not necessarily limited to, the following:
 - 1. Mechanical door hardware.
 - 2. .
- C. Related Sections:
 - 1. Division 08 Section "Hollow Metal Doors and Frames".
- 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. 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.

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. 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.
- D. 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.
- E. 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.

1.4 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.
- F. Each unit to bear third party permanent label demonstrating compliance with the referenced 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 to manufacturer's instructions and recommendations and according to approved schedule.

1.5 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".

1.6 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 Hardware and Electrical Connections: Coordinate the layout and installation of scheduled electrified door hardware and related access control equipment with required connections to source power junction boxes, low voltage power supplies, detection and monitoring hardware, and fire and detection alarm systems.
- C. 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.

1.7 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. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.
- D. Special Warranty Periods:
1. Ten years for mortise locks and latches.

1.8 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.
- B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:
1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.
- C. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.2 HANGING DEVICES

- A. Hinges: ANSI/BHMA A156.1 certified 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. Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
4. Hinge Options: Comply with the following:
 - a. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.
5. Manufacturers:
 - a. Hager Companies (HA).
 - b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK).
 - c. Stanley Hardware (ST).

2.3 DOOR OPERATING TRIM

- A. Flush Bolts and Surface Bolts: ANSI/BHMA A156.3 and A156.16, Grade 1, certified.
 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. Door Controls International (DC).
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
 - c. Trimco (TC).

2.4 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.
- B. Source Limitations: Obtain each type of keyed cylinder and keys from the same source manufacturer as locksets and exit devices, unless otherwise indicated.
- C. 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.
- D. Removable Cores: Provide removable cores as specified, core insert, removable by use of a special key, and for use with only the core manufacturer's cylinder and door hardware.
- E. 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 WTCC preferred brand.
- F. 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).
 - 4. Construction Control Keys (where required): Two (2).
 - 5. Permanent Control Keys (where required): Two (2).
- G. Construction Keying: Provide temporary keyed construction cores.
- H. 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.

2.5 MECHANICAL LOCKS AND LATCHING DEVICES

- A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.
1. Mortise locks to be certified Security Grade 1.
 2. Manufacturers:
 - a. Corbin Russwin Hardware (RU) - ML2000 Series.
 - b. Sargent Manufacturing (SA) - 8200 Series.
 - c. Schlage (SC) - L9000 Series.

2.6 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.

2.7 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 certified 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. Hiawatha, Inc. (HI).
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
 - c. 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 aluminum 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. Rixson Door Controls (RF).
 - c. Sargent Manufacturing (SA).

2.8 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. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- C. Manufacturers:
 - 1. National Guard Products (NG).
 - 2. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).
 - 3. Reese Enterprises, Inc. (RE).

2.9 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.

2.10 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.

3.3 INSTALLATION

- A. Install each item of mechanical hardware to comply with manufacturer's written instructions and according to specifications.
- 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. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
 - 3. 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. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

- E. 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 FIELD QUALITY CONTROL

- A. Field Inspection (Punch Report): Reference Division 01 Sections “Closeout Procedures”. Produce project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include list of items to be completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.
 - 1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.
 - 2. Submit documentation of incomplete items in the following formats:
 - a. PDF electronic file.
 - b. Electronic formatted file integrated with the Openings Studio™ door opening management software platform.

3.5 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.

3.6 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.

3.7 DEMONSTRATION

- A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 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. RO - Rockwood
5. VD - Von Duprin
6. SC - Schlage
7. AD - Adams Rite
8. GS - ASSA ABLOY Glass Solutions
9. HS - HES
10. LC - LCN Closers
11. SA - SARGENT
12. HD - HID
13. SU - Securitron
14. OT - Other

Hardware Sets

Set: 001

Doors:

Description: Exterior doors at Training Tower

6 Hinge (heavy weight)	T4A3386 NRP 4-1/2" x 4-1/2"	US32D MK
1 Classroom	L9070 .03A .F	630 SC
1 Permanent Core	Everest FSIC GMK	US32D SC
3 Silencer	608-RKW	RO
1 Threshold	2715AK WS10SS	PE

Notes:

Set: 002

Doors:

Description: Interior doors at Training Towers

3 Hinge (heavy weight)	T4A3386 NRP 4-1/2" x 4-1/2"	US32D MK
1 Passage Set	L9010 .03A .F	630 SC
1 Wall Stop	406	US32D RO
3 Silencer	608-RKW	RO

Notes:

Set: 003

Doors:

Description: Exterior access Pair at Training Tower

6 Hinge (heavy weight)	T4A3386 NRP 4-1/2" x 4-1/2"	US32D MK
2 Flush Bolt	582-8	US32D RO
1 Privacy Set	L9070 .03A .F	630 SC
1 Surf Overhead Hold Open	9-X26	630 RF
1 Threshold	2715AK WS10SS	PE
1 Gasketing	2891AV TKSP8 X Head & Jamb	PE
1 Rain Drip Protection Strip	346	C PE
1 Astragal Seal	S771BL 7'	PE

Notes: Overlapping astragal by door manufacturer. Provide drip edge across top of door.

Set: 004

Doors:101, 102, 103

Description: Toilet room doors

3 Hinge (heavy weight)	T4A3386 NRP 4-1/2" x 4-1/2"	US32D MK
1 Classroom Set w/Indicator	L9056 .03A .L283-722 .L583-363	630 SC
1 Permanent Core	Everest FSIC GMK	US32D SC
1 Surf Overhead Hold Open	9-X26	630 RO
1 Threshold	1715AK WS10SS	PE
3 Silencer	608-RKW	RO

Notes: L283-722 Outside trim OCCUPIED/VACANT indicator with keyed override XL13-439

Set: 005

Doors:104, 105

Description: Exterior doors at ELEC/IT & UTILITY ROOM

6 Hinge (heavy weight)	T4A3386 NRP 4-1/2" x 4-1/2"	US32D MK
1 Classroom	L9070 .03A .F	630 SC
1 Permanent Core	Everest FSIC GMK	US32D SC
3 Silencer	608-RKW	RO
1 Surf Overhead Hold Open	9-X26	630 RO
1 Threshold	1715AK WS10SS	PE

END OF SECTION 087100

SECTION 092216 - NON-STRUCTURAL 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. Section Includes:
 - 1. Non-load-bearing steel framing systems for interior partitions.
 - 2. Suspension systems for interior ceilings and soffits.
 - 3. Grid suspension systems for gypsum board ceilings.
- B. Related Requirements:
 - 1. Section 054000 "Cold-Formed Metal Framing" for exterior and interior load-bearing and exterior non-load-bearing wall studs.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of code-compliance certification for studs and tracks.
- B. Evaluation Reports: For embossed 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.

1.5 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 or the Steel Stud Manufacturers Association.

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, 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 on Drawings, according to ASTM E 90 and classified according to ASTM E 413 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.

2.2 FRAMING SYSTEMS

- A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
 2. Protective Coating: ASTM A 653/A 653M, ***G40***, hot-dip galvanized unless otherwise indicated.
- B. Studs and Tracks: ASTM C 645. Use either steel studs and tracks or embossed steel studs and tracks.
1. Steel Studs and Tracks:
 - 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 Building Systems.
 - 3) Custom Stud.
 - 4) Jaimes Industries.
 - 5) MarinoWARE.
 - 6) MBA Building Supplies.
 - 7) MRI Steel Framing, LLC.
 - 8) Phillips Manufacturing Co.
 - 9) SCAFCO Steel Stud Company.
 - 10) Steel Construction Systems.
 - b. Minimum Base-Metal Thickness: As required by performance requirements for horizontal deflection.
 - c. Depth: As indicated on Drawings.
 2. Embossed Steel Studs and Tracks: Roll-formed and embossed with surface deformations to stiffen the framing members so that they are structurally equivalent to conventional ASTM C 645 steel studs and tracks.
 - 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 Building Systems.
 - 3) MarinoWARE.
 - 4) MBA Building Supplies.
 - 5) Phillips Manufacturing Co.
 - 6) SCAFCO Steel Stud Company.
 - 7) Steel Construction Systems.
 - 8) Telling Industries.
 - 9) The Steel Network, Inc.
 - b. Minimum Base-Metal Thickness: As required by horizontal deflection performance requirements.

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- c. Depth: As indicated on Drawings.
- C. Slip-Type Head Joints: At all wall locations noted to be constructed to deck above.
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 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 Building Systems.
 - 3) Fire Trak Corp.
 - 4) MarinoWARE.
 - 5) SCAFCO Steel Stud Company.
 - 6) Steel Construction Systems.
 - 7) Super Stud Building Products Inc.
 - 8) The Steel Network, 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 Building Systems.
 - 3) MarinoWARE.
 - 4) MBA Building Supplies.
 - 5) Metal-Lite.
 - 6) Perfect Wall, Inc.
 - 7) SCAFCO Steel Stud Company.
 - 8) Steel Construction Systems.
 - 9) Telling Industries.
 - 10) The Steel Network, Inc.
- D. 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 Building Systems.
 - c. Fire Trak Corp.
 - d. MarinoWARE.
 - e. Metal-Lite.
 - f. Perfect Wall, Inc.
 - g. SCAFCO Steel Stud Company.
 - h. Steel Construction Systems.
 - i. The Steel Network, Inc.

-
- E. 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 Building Systems.
 - b. MarinoWARE.
 - c. MRI Steel Framing, LLC.
 - d. SCAFCO Steel Stud Company.
 - e. Steel Construction Systems.
 2. Minimum Base-Metal Thickness: 0.0296 inch.
- F. Cold-Rolled Channel Bridging: Steel, 0.0538-inch minimum base-metal thickness, with minimum 1/2-inch- 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 Building Systems.
 - b. MarinoWARE.
 - c. MRI Steel Framing, LLC.
 - d. SCAFCO Steel Stud Company.
 - e. Steel Construction Systems.
 2. Depth: 1-1/2 inches.
 3. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch- thick, galvanized steel.
- G. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
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 Building Systems.
 - b. Jaimes Industries.
 - c. MarinoWARE.
 - d. MRI Steel Framing, LLC.
 - e. SCAFCO Steel Stud Company.
 - f. Steel Construction Systems.
 2. Minimum Base-Metal Thickness: 0.0296 inch.
 3. Depth: As indicated on Drawings 1-1/2 inches.
- H. Resilient Furring Channels: 1/2-inch- 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 Building Systems.
 - b. MarinoWARE.
 - c. MRI Steel Framing, LLC.
 - d. SCAFCO Steel Stud Company.
 - e. Steel Construction Systems.
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2. Configuration: Asymmetrical or hat shaped.
- I. Cold-Rolled Furring Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch- wide flanges.
 1. Depth: 3/4 inch.
 2. Furring Brackets: Adjustable, corrugated-edge-type steel sheet with minimum uncoated-steel thickness of 0.0329 inch.
 3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.
- J. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum uncoated-metal thickness of 0.0179 inch, 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 Building Systems.
 - b. MarinoWARE.
 - c. MRI Steel Framing, LLC.
 - d. SCAFCO Steel Stud Company.
 - e. Steel Construction Systems.

2.3 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.
- B. Hanger Attachments to Concrete:
 1. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 AC193 AC58 or AC308 as appropriate for the substrate.
 - a. Uses: Securing hangers to structure.
 - b. Type: Torque-controlled, expansion anchor torque-controlled, adhesive anchor or adhesive anchor.
 - c. 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.
 - d. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.
 2. Power-Actuated Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.
- D. Flat Hangers: Steel sheet, 1 by 3/16 inch by length indicated.
- E. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.0538 inch and minimum 1/2-inch- wide flanges.
 1. Depth: 2-1/2 inches.

F. Furring Channels (Furring Members):

1. Cold-Rolled Channels: 0.0538-inch uncoated-steel thickness, with minimum 1/2-inch- wide flanges, 3/4 inch deep.
2. Steel Studs and Tracks: ASTM C 645.
 - a. Minimum Base-Metal Thickness: 0.0269 inch.
 - b. Depth: 2-1/2 inches.
3. Embossed Steel Studs and Tracks: ASTM C 645.
 - a. Minimum Base-Metal Thickness: 0.0190 inch.
 - b. Depth: 2-1/2 inches.
4. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.
 - a. Minimum Base-Metal Thickness: 0.0296 inch.
5. Resilient Furring Channels: 1/2-inch- deep members designed to reduce sound transmission.
 - a. Configuration: Asymmetrical or hat shaped.

G. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.

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. Armstrong World Industries, Inc.
 - b. Rockfon (Rockwool International).
 - c. USG Corporation.

2.4 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 D 226/D 226M, 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 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.
- B. Coordination with Sprayed Fire-Resistive Materials:
 - 1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling tracks to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches o.c.
 - 2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that are required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.3 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754.
 - 1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C 841 that apply to framing installation.
 - 2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.
 - 3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
 - 4. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 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 INSTALLING FRAMED ASSEMBLIES

- 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 o.c. unless otherwise indicated.
 - 2. Multilayer Application: 16 inches o.c. unless otherwise indicated.
 - 3. Tile Backing Panels: 16 inches o.c. unless otherwise indicated.

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- 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 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.
 - E. Direct Furring:
 - 1. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches 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 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 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 from corner and cut insulation to fit.
 - G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.
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3.5 INSTALLING CEILING 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 o.c.
 - 2. Furring Channels (Furring Members): 16 inches 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.
- F. 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.
- G. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION

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.

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 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.

1.5 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. METAL EDGE STRIPS

B. General: Fabricate to sizes and profiles as indicated.

C. Factory formed metal reveal for wall J-Trim:

- 1. Basis of Design: Fry Reglet, WCTBT125-217
- 2. Factory formed metal edge to be installed during gypsum installation in the set bed for full integration with wall system.
- 3. Material and color to be chosen from manufacturer's full range of colors and finishes.

EXECUTION

2.9 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.

2.10 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.

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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.
- 2.11 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 vertical walls in the simulation tank area.***
- 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
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- 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.

2.12 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.

2.13 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.

2.14 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 Lobby 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.

2.15 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

SECTION 096726 – RESINOUS 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. Resinous flooring
 - 2. Integral cove base and accessories.

1.3 REFERENCES

- A. ASTM C579, Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
- B. ASTM D2240, Standard Test Method for Rubber Property—Durometer Hardness.
- C. ASTM D2369, Standard Test Method for Volatile Content of Coatings.
- D. ASTM D4060, Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.
- E. ASTM D4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
- F. For additional standards please refer to Product Data Sheets

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review manufacturer's written instructions for substrate preparation and environmental conditions affecting resinous flooring installation.
 - 2. Review details of integral cove bases.
 - 3. Review manufacturer's written instructions for installing resinous flooring systems.
 - 4. Review protection measures for adjacent construction and installed flooring, floor drainage requirements, curbs, base details, and so forth.

1.5 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's product data, including physical properties and colors available.
- B. Product Samples: Submit Architectural Standard sample panels demonstrating the final finish, as applied. Minimum size 12" x 12". The Standard shall be approved in writing by the Architect and shall be the final standard of acceptance of the finish.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer
- B. Material Certificates: For each resinous flooring component.
- C. Material Test Reports: For each resinous flooring component.

- D. Field quality-control reports.
- 1.7 CLOSEOUT SUBMITTALS
 - A. Maintenance Data: For resinous flooring to include in maintenance manuals.
- 1.8 QUALITY ASSURANCE
 - A. Applicator Qualifications:
 - 1. Pre-Qualification: Each bidder for this project shall be pre-qualified and approved in writing by the material manufacturer.
 - 2. Applicator Experience: Each bidder must have a minimum 5 years experience in the application of the type of system specified. Contractor shall submit a list of five projects of similar size, scope and complexity.
- 1.9 DELIVERY, STORAGE AND HANDLING
 - A. Delivery:
 - 1. Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name, manufacturer, batch or lot number, and date of manufacture.
 - 2. Material should be delivered to job site and checked for completeness and shipping damage prior to job start.
 - B. Storage:
 - 1. Store materials in accordance with manufacturer's written instructions.
 - 2. Keep containers sealed until ready for use. Material should be stored in a dry, enclosed, protected area from the elements.
 - 3. Do not subject material to excessive heat or freezing.
 - 4. Shelf life: Established based on manufacturer's written recommendation for each material being used.
 - C. Handling: Protect materials during handling and application to prevent damage or contamination.
 - D. Condition materials for use accordingly to manufacturer's written instructions prior to application.
 - E. Record material lot number and quantity delivered to jobsite/storage.
- 1.10 SITE CONDITIONS
 - A. Do not install the Work of this Section outside of the following environmental ranges with Manufacturers' written acceptance:
 - 1. Material Temperature: Precondition material for at least 24 hours between 65° to 75°F (18° to 24°C)

2. Ambient Temperature: Minimum/Maximum 60°/85°F (10°/30°C)
 3. Substrate Temperature: Minimum/Maximum 60°/85°F (10°/30°C). Substrate temperature must be at least 5°F (3°C) above measured Dew Point.
 4. Mixing and Application attempted at Material, Ambient and/or Substrate Temperature conditions less than 65°F (18°C) will result in a decrease in product workability and slower cure rates.
 5. Relative Ambient Humidity: Minimum ambient humidity 30%, maximum ambient humidity 75% (during application and curing)
 6. Measure and confirm Substrate Moisture Content, Ambient Relative Humidity, Ambient and Surface Temperature and Dew Point.
- B. Substrate moisture:
1. Moisture content of concrete substrate must be $\leq 4\%$ by mass as measured with a Tramex® CME/CMExpert type concrete moisture meter.
 2. Additionally, relative humidity tests may be conducted per ASTM F2170 and values must be $\leq 85\%$.
 3. If moisture content of concrete substrate is $> 4\%$ by mass as measured with Tramex® CME/CMExpert type and/or if relative humidity tests per ASTM F2170 exceed values $> 85\%$, consider moisture mitigation systems or moisture tolerant primer.
- C. Utilities, including electric, water, HVAC and permanent lighting to be supplied by General Contractor
- D. Maintain constant ambient room temperature of plus or minus 15°F (plus or minus 7°C) with a minimum temperature of 50°F (10°C) and maximum temperature of 85°F (30°C). Maintain constant ambient room temperature for 48 hours before, during and after installation, or until cured. Do not apply while ambient and temperatures are rising.
- E. Erect suitable barriers and post legible signs at points of entry to prevent traffic and trades from entering the work area during application and cure period of the floor.
- F. Protection of finished floor from damage by subsequent trades shall be the responsibility of the General Contractor.
- G. Insure adequate ventilation and air flow.
- 1.11 WARRANTY
- A. Manufacturer's warranty covering the resinous flooring against defects in materials for one year from date of installation.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
1. Sika Corp.
 2. Stonhard
 3. Dur-A-Flex
 4. Sherwin Williams/General Polymers

2.2 RESINOUS FLOORING

- A. Resinous Flooring System: Abrasion-, impact-, and chemical-resistant, aggregate-filled, resin-based monolithic floor surfacing designed to produce a seamless floor and integral cove base.
- B. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer. Obtain secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from manufacturer recommended in writing by manufacturer of primary materials.
- C. System Characteristics:
 - 1. Color and Pattern: As selected by Architect from manufacturer's full range.
 - 2. Wearing Surface: Textured for slip resistance, medium grit.
 - 3. Overall System Thickness: 3/16 inch (4.8 mm).
- D. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested in accordance with test methods indicated:
 - 1. Compressive Strength: 10,000 psi after 7 days minimum in accordance with ASTM C579.
 - 2. Tensile Strength: 2,000 psi minimum in accordance with ASTM C307.
 - 3. Flexural Modulus of Elasticity: 4,300 psi minimum in accordance with ASTM C580.
 - 4. Water Absorption: 0.1% maximum in accordance with ASTM C413.
 - 5. Coefficient of Thermal Expansion: 1.8×10^{-5} mm/ °C mm per ASTM C 531.
 - 6. Impact Resistance: No chipping, cracking, or delamination and not more than 1/16-inch (1.6-mm) permanent indentation in accordance with MIL-D-3134J.
 - 7. Resistance to Elevated Temperature: No slip or flow of more than 1/16 inch (1.6 mm) in accordance with MIL-D-3134J.
 - 8. Abrasion Resistance: 0.08 gm maximum weight loss in accordance with ASTM D4060.
 - 9. Hardness: 85 to 90 , Shore D in accordance with ASTM D2240.
 - 10. Bond Strength: 400 psi, 100 percent concrete failure per ACI 503R.
- E. Primer: Type recommended in writing by resinous flooring manufacturer for substrate and resinous flooring system indicated.
 - 1. Formulation Description: 100 percent solids.
- F. Waterproofing Membrane: Type recommended in writing by resinous flooring manufacturer for substrate and resinous flooring system indicated.
 - 1. Formulation Description: Only if application above grade.
- G. Reinforcing Membrane: Flexible resin formulation that is recommended in writing by resinous flooring manufacturer for substrate and resinous flooring system indicated and that inhibits substrate cracks from reflecting through resinous flooring.
- H. Patching and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended in writing by manufacturer for installation indicated.
- I. Body Coat, 3 component trowel-applied mortar:
 - 1. Resin: Epoxy.
 - 2. Formulation Description: 100% solids.

3. Installation Method: Troweled or screeded.
4. Number of Coats: One.
5. Thickness of Coats: 3/16 inch (4.8 mm).
6. Aggregates: Pigment blended aggregate.

J. Topcoat, broadcast quartz aggregate:

1. Resin: Epoxy.
2. Formulation Description: 100% high solids.
3. Type: Pigmented.
4. Number of Coats: One.
5. Finish: Standard.
6. Pattern: Tweed.

K. Topcoat:

1. Resin: Epoxy.
2. Formulation Description: 100% solids.
3. Type: Clear.
4. Number of Coats: One.
5. Finish: Gloss

2.3 INTEGRAL COVE BASE ACCESSORIES

- A. Precast, Integral Cove Base: Impact-resistant, polymer-resin, cove base moldings with a grit profile to promote adhesion of resinous flooring and recommended in writing by resinous flooring manufacturer.
1. Radius Cove Base: 4-inch- (102-mm-) high base molding that provides approximately 1-inch (25-mm) radius cove at floor-to-wall joint; for adhesive installation as substrate for resinous flooring system to form an integral cove base.
 - a. Preformed Inside and Outside Corners: Provide manufacturer's standard square inside and 3/4- to 1-inch (19- to 25-mm) bullnose outside corners.
- B. Installation Adhesive: As recommended in writing by accessory manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine surfaces to receive flooring system. Notify General Contractor if surfaces are not acceptable. Do not begin surface preparation or application until unacceptable conditions have been corrected. Do not apply to substrate treatments for moisture, repair, or leveling not of the same Manufacturer.
- B. Surface must be clean, sound and dry. Remove dust, laitance, grease, curing compounds bond inhibiting impregnations, waxes and any other contaminants. All projections, rough spots, etc. should be dressed off to achieve a level surface prior to the application.
- C. Concrete substrate to have a minimum compressive strength of 3,500 psi (24 MPa) at 28 days and a minimum of 215 psi (1.5 MPa) in tension at time of application.

- D. Substrate moisture:
 - 1. Measure and confirm Substrate Moisture Content, Ambient Relative Humidity, Ambient and Surface Temperature and Dew Point.
 - 2. Confirm and record above values at least once every 3 hours during installation, or more frequently whenever conditions change (e.g. Ambient Temperature rise/fall, Relative Humidity increase/decrease, etc.).
- E. Ensure concrete substrate conforms to the minimum requirements of the flooring manufacturer.
- F. Flooring system shall not be applied to sand-cement setting beds. Sand-cement beds shall be removed to structural concrete substrate and re-leveled/sloped as necessary to achieve grade and/or adequate drainage.
- G. Flooring system shall not be applied to asphaltic or bitumen membranes, soft wood, aluminum, copper or fiberglass reinforced polyester/vinyl ester composites.
- H. Application to glazed or vitrified brick and tile, structural wood, steel shall only be permitted with Manufacturer's written recommendation.

3.2 SURFACE PREPARATION

- A. Prepare surface to receive flooring systems in accordance with manufacturer's written instructions.
- B. Remove dirt, oil, grease, wax, laitance, curing compounds, water-soluble concrete hardeners, and other surface contaminants. Remove sealers, finishes, and paints. Remove unsound concrete by appropriate mechanical means.
- C. Concrete: Shall be cleaned and prepared to achieve laitance-free and contaminant-free, open textured surface by shot blasting or equivalent mechanical means (CSP level as per ICRI guidelines and manufacturer's written recommendation).
- D. Chemical Surface Preparation: Chemical surface preparation (acid etching) is unacceptable and will void Manufacturer's warranty.
- E. Control joints and cracks: Provide repair and treatment of control joints and surface cracks utilizing manufacturer's standard materials and installation details.

3.3 APPLICATION

- A. Mix and apply material with strict adherence to manufacturer's written installation procedures and coverage rates.
- B. Follow Manufacturer's written recommendations on terminations and connections to walls, drains, doorways, columns and floor-to-floor transitions.
- C. Do not apply while ambient and substrate temperatures are rising.
- D. Apply resinous flooring with care to ensure that no laps, voids, or other marks or irregularities are visible, and with an appearance of uniform color, sheen and texture, all within limitations of materials and areas concerned.
- E. Match colors and textures of approved samples.
- F. Install cove base *as* shown in the contract documents, and in accordance with manufacturer's written instructions.

3.4 CLEAN UP

- A. Disposal of this product, solution and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements.
- B. Empty containers should be taken to an approved waste handling site for recycling or disposal.

3.5 PROTECTION

- A. Freshly applied material should be protected from dampness, condensation and water for at least 72 hrs.
- B. Beware of air flow and changes in air flow. Introduction of dust, debris, and particles, etc. may result in surface imperfections and other defects.
- C. Follow manufacturer's written recommendation with respect to cure, wait time and return to service.

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. 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.
- B. 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 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.

1.7 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. 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.

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

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. Section includes surface preparation and the application of high-performance coating systems on the following substrates:
 - 1. Interior Substrates:
 - a. Concrete, horizontal surfaces.
 - b. Concrete masonry units (CMUs).
 - c. Steel.
 - d. Galvanized metal.
 - e. Gypsum board.
- B. Related Requirements:
 - 1. Section 051200 "Structural Steel Framing" for shop priming of structural steel with primers specified in this Section.
 - 2. Section 055213 "Pipe and Tube Railings" for shop priming painting pipe and tube railings with coatings specified in this Section.
 - 3. Section 099113 "Exterior Painting" for general field painting.
 - 4. Section 099123 "Interior Painting" for general field painting.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 - 1. Indicate VOC content.
- B. Samples for Verification: For each type of coating system and each color and gloss of topcoat indicated.
 - 1. Submit Samples on rigid backing, 8 inches 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.

- C. Product List: Cross-reference to coating system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.
- D. Shop Drawings: Provide shop drawing plans and elevations for all accent wall locations.

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. Coatings: 5 percent, but not less than 1 gal. 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.
 - 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 coatings only when temperature of surfaces to be coated and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
- C. Do not apply exterior coatings in snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Basis of Design: The Sherwin-Williams Company
 - 2. Benjamin Moore & Co.
 - 3. PPG Architectural Coatings.

2.2 INTERIOR PAINTING, 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.
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.
3. Products shall be of same manufacturer for each coat in a coating system.

B. Colors: As selected by Architect from manufacturer's full range.

2.3 SOURCE QUALITY CONTROL

A. Testing of Coating Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample coating materials. Contractor will be notified in advance and may be present when samples are taken. If coating 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.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

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. Concrete: 12 percent.
 2. Masonry (CMU): 12 percent.
 3. 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 in "MPI Architectural Painting Specification Manual" applicable to substrates and coating 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 coatings, 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 coating systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
 - 1. Clean surfaces with pressurized water. Use pressure range of 1500 to 4000 psi (10 350 50 27 580 kPa) at 6 to 12 inches (150 to 300 mm).
 - 2. Abrasive blast clean surfaces to comply with SSPC-SP 7/NACE No. 4.
- E. Masonry Substrates: Remove efflorescence and chalk. Do not coat surfaces if moisture content, alkalinity of surfaces, or alkalinity of mortar joints exceeds that permitted in manufacturer's written instructions.
 - 1. Clean surfaces with pressurized water. Use pressure range of 100 to 600 psi (690 to 4140 kPa) at 6 to 12 inches (150 to 300 mm).
- 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 coatings.

3.3 APPLICATION

- A. Apply high-performance coatings according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
 - 1. Use applicators and techniques suited for coating and substrate indicated.
 - 2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Coat backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 - 4. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.
- D. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

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 coatings for dry film thickness.
 - 1. Contractor shall touch up and restore coated surfaces damaged by testing.
 - 2. If test results show that dry film thickness of applied coating does not comply with coating manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with coating 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 coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from coating operation. Correct damage to work of other trades by cleaning, repairing, replacing, and recoating, 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 coated surfaces.

3.6 INTERIOR PAINT SCHEDULE

A. CMU Substrates:

- 1. Pre-Catalyzed Epoxy System:
 - a. Block Filler: S-W PrepRite Int/Ext Latex Block Filler, B25W25.
 - b. Intermediate Coat: Pre-Catalyzed Epoxy, matching topcoat.
 - c. Topcoat: S-W Pro Industrial Pre-Catalyzed WaterbasedEpoxy Semi-Gloss, K46 Series.

B. Steel Substrates:

- 1. Light Industrial System:
 - a. Prime Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-1300.
 - b. Intermediate Coat: Light industrial coating, matching topcoat.
 - c. Topcoat: S-W Pro Industrial Waterbased Alkyd Urethane Semi-Gloss, B53-1150 Series.

C. Galvanized-Metal Substrates:

- 1. Light Industrial System:
 - a. Prime Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-1300.
 - b. Intermediate Coat: Light industrial coating, matching topcoat.
 - c. Topcoat: S-W Pro Industrial Waterbased Alkyd Urethane Semi-Gloss, B53-1150 Series.

D. Gypsum Board Substrates:

- 1. Epoxy System (Restrooms/Shower Areas, Walls & Ceilings):
 - a. Prime Coat: S-W ProMar 200 Zero-VOC Interior Latex Primer, B28W2600.
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: S-W Pro Industrial Waterbased Catalyzed Epoxy Eg-Shel, B73-360.

E. Gypsum Board Substrates:

- 1. Latex System (Non-Wet Areas, Walls):
 - a. Prime Coat: S-W ProMar 200 Zero-VOC Interior Latex Primer, B28W2600.
 - b. Intermediate Coat: Latex, matching topcoat.

- c. Topcoat: S-W ProMar 200 Zero-VOC Interior Latex Eg-Shel, B20-2600 Series.
- F. Gypsum Board Substrates:
 - 1. Latex System (Non-Wet Areas, Ceilings):
 - a. Prime Coat: S-W ProMar 200 Zero-VOC Interior Latex Primer, B28W2600.
 - b. Intermediate Coat: Latex, matching topcoat.
 - c. Topcoat: S-W ProMar 200 Zero-VOC Interior Latex Flat, B30-2600 Series.

3.7 INTERIOR PAINTING COLOR SCHEDULE

- A. See Finish Legend

END OF SECTION

SECTION 099600 - HIGH-PERFORMANCE COATINGS

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 surface preparation and the application of high-performance coating systems on the following substrates:
 - 1. Interior Substrates:
 - a. Concrete masonry units (CMUs).
 - b. Galvanized metal.
 - c. Gypsum board.
 - d. Fiberglass.

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 D 523.
- B. MPI Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- C. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- D. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
- E. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
- F. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
- G. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

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 indicated.
- C. Samples for Verification: For each type of coating system and each color and gloss of topcoat indicated.

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 coating 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. Coatings: 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 coating system indicated 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 coating system.
 - a. Wall and Ceiling Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
 - b. Other Items: Architect will designate items or areas required.
 - c. Compatibility and Adhesion: Check after one week of drying and curing by testing in accordance with ASTM D3359; Adhesion by tape test. If coating system is incompatible, additional surface preparation up to and including complete removal may be 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.

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 coatings only when temperature of surfaces to be coated and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
- B. Do not apply coatings 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.
- C. Do not apply exterior coatings in snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Behr Paint Company; Behr Process Corporation.
 - 2. Benjamin Moore & Co.
 - 3. PPG Paints; PPG Industries, Inc.
 - 4. Sherwin-Williams Company (The).
- B. Products (EPT-1, EPT-2, EPT-3): Subject to compliance with requirements, provide product listed in the Interior High-Performance Coating Schedule for the coating category indicated.

2.2 HIGH-PERFORMANCE COATINGS, 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.
 - 3. Products shall be of same manufacturer for each coat in a coating system.
- C. Colors: As indicated in color schedule.

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. Masonry (Clay and CMUs): 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 in "MPI Architectural Painting Specification Manual" applicable to substrates and coating 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 coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
- D. Masonry Substrates: Remove efflorescence and chalk. Do not coat surfaces if moisture content, alkalinity of surfaces, or alkalinity of mortar joints exceeds that permitted in manufacturer's written instructions.
 - 1. Clean surfaces with pressurized water. Use pressure range of 100 to 600 psi (690 to 4140 kPa) at 6 to 12 inches (150 to 300 mm).
- E. 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 coatings.

3.3 APPLICATION

- A. Apply high-performance coatings according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
 - 1. Use applicators and techniques suited for coating and substrate indicated.
 - 2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Coat backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 - 4. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- B. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.
- C. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

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 coatings for dry film thickness.
 - 1. Contractor shall touch up and restore coated surfaces damaged by testing.
 - 2. If test results show that dry film thickness of applied coating does not comply with coating manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with coating 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 coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from coating operation. Correct damage to work of other trades by cleaning, repairing, replacing, and recoating, 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 coated surfaces.

3.6 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE

- A. CMU Substrates:
 - a. Block Filler:
 - 1) S-W Cement-Plex 875 Acrylic Block Filler B42 Series, at 10 to 20 mils (0.254 to 0.508 mm) dry, per coat.
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: Epoxy, high-build, semi-gloss:
 - 1) S-W Macropoxy 646-100, B58-600 Series, at 5.0 to 10 mils (0.127 to 0.254 mm) dry, per coat.
- B. Galvanized-Metal Substrates:
 - 1. Pigmented Polyurethane over Vinyl Wash Primer System:
 - a. Prime Coat: Primer, vinyl wash:
 - 1) S-W DTM Wash Primer, B71Y1, at 0.7 to 1.3 mils (0.018 to 0.033 mm) dry, per coat.
 - b. Intermediate Coat: Polyurethane, two-component, pigmented, matching topcoat.
 - c. Topcoat: Polyurethane, two-component, pigmented, gloss:
 - 1) S-W Pro Industrial Waterbased Acrolon 100 Polyurethane, B65-720 Series, at 2.0 to 4.0 mils (0.051 to 0.102 mm) dry, per coat.
- C. Fiberglass Substrates:
 - 1. Pigmented Polyurethane System MPI INT 6.7E:
 - a. Prime Coat: Epoxy, gloss, MPI #77.
 - b. Intermediate Coat: Epoxy, matching prime coat.
 - c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6), MPI #72.
- D. Gypsum Board Substrates:
 - 1. Epoxy System:
 - a. Prime Coat: Primer sealer, latex, interior:
 - 1) S-W ProMar 200 Zero VOC Interior Latex Primer, B28W2600, at 1.0 mils (0.025 mm) dry, per coat.
 - b. Intermediate Coat: Epoxy, gloss matching topcoat.
 - c. Topcoat: Epoxy, semi-gloss:
 - 1) S-W Macropoxy 646-100, B58-600 Series, at 5.0 to 10 mils (0.127 to 0.254 mm) dry, per coat.

END OF SECTION

SECTION 099659 – FIBERGLASS MAT REINFORCED WALL COATING SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. This section specifies a high performance, abuse and heat resistant, epoxy wall coating system.

1.2 REFERENCES

- A. ASTM D 1044-99 Test Method for Resistance of Transparent Plastics to Surface Abrasion
- B. ASTM D 5420-04 Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Striker Impacted by a Falling Weight (Gardner Impact)
- C. ASTM D 2369-10e1 Test Method for Volatile Content of Coatings

1.3 SYSTEM PERFORMANCE REQUIREMENTS

- A. Provide a high performance, heavy-duty, Fiberglass mat reinforced wall and ceiling coating system that, when cured, produces the following typical properties:

<u>PROPERTY</u>	<u>TEST METHOD</u>	<u>RESULT</u>
Impact Resistance	Gardner Impact	>160 in • lb
Abrasion Resistance	ASTM D-1044-99	0.019 gram loss
VOC (g/l)	ASTM D2369-10e1	11.3 g/l

Independent testing to support resistance to bacteria, mold and yeasts

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's product data, including physical properties and colors available.
- B. Submit two mock-up samples that are representative of the finished wall, texture and color.

1.5 QUALITY ASSURANCE

- A. Applicator Qualifications
1. Pre-Qualification: Each bidder for this project shall be pre-qualified and approved in writing by the material manufacturer.
 2. Applicator Experience: Each bidder must have a minimum 5 years experience in the application of the type of system specified. Contractor shall submit a list of five projects of similar size, scope and complexity.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver product in factory packages, clearly marked with manufacturer's identification, printed instructions, lot numbers and shelf life expiration date for each component.
- B. Store materials at 50°F to 90°F (10°C to 32 °C) in dry environment away from sunlight, heat, or other hazards. Do not allow materials to freeze.

1.7 PROJECT CONDITIONS

- A. Maintain minimum substrate surface temperature of 60°F (12°C) for a minimum of 48 hours before, during and after installation, or until cured.
- B. Provide adequate ventilation and proper lighting.
- C. Advise other trades of fixtures and fittings not to be installed until system is cured, such as: radiators, painting, decorating, floor-supported equipment or cabinetwork, caulking, plumbing, fixtures, etc.
- D. Work areas shall be kept free of traffic and no trades shall be permitted in rooms during the application and curing of the coating.
- E. Protect adjacent surfaces from damage resulting from work of this trade. If necessary, mask and/or cover adjacent surfaces, fixtures, equipment, etc. by suitable means.
- F. Gypsum drywall is only suitable for dry areas. Other wall board products may be utilized for added impact resistance or in wet high abuse environments. Install wall board in accordance with board product manufacturer's directions and with the factory edge 1/4 inch above floor line. Wall board installer shall tape and fill joints; fill all fastener heads, corners and transitions and other indentations for smooth, paint-ready finished surface. A good level 3 or level 4 finish is acceptable. A level 5 finish should not be used. Drywall shall be sealed with a compatible sealer prior to the installation of the high performance wall coating.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
 - 1. Sika Corp.
 - 2. Dur-A-Wall by Dur-A-Flex
 - 3. General Polymers by Sherwin Williams

2.2 MATERIALS

- A. Fiberglass Mat Reinforced Wall System: Manufacturer's Fiberglass Mat Reinforced Wall Coating System with urethane finish.
1. Primer : Manufacturer's Bonding Primer 5 mils wft (required on drywall or moisture resistant board products and properly prepared, previously coated substrates)
 2. Base Coat: Manufacturer's Fiber Reinforced Wall Coating, 8-10 mils (coverage rate 160-200 sq.ft./gal).
 3. Tie Coat: Manufacturer's Fiber Reinforced Wall Coating, 7-9 mils (coverage rate 178-229 sq.ft./gal)
 4. Intermediate Coat: Manufacturer's Fiber Reinforced Wall Coating, 8-10 mils (coverage rate 160-200 sq.ft./gal)
 5. Finish Coats: Two coats of Manufacturer's Waterbased Urethane Wall Coating, 4 mils coverage rate (400 sq.ft./gal).

PART 3 - EXECUTION

3.1 INSPECTION

- A. Before starting work, ensure that environmental and site conditions are suitable for application and curing.
- B. Inspect surfaces for acceptability of levelness, moisture content and other critical factors at time of installation.
- C. Report in writing to architect/engineer, with copy to manufacturer, of deficiencies that could impair work. Surfaces must be approved by the certified contractor prior to application of the system.

3.2 SURFACE PREPARATION

- A. Prepare surfaces in accordance with manufacturer's instructions.
- B. Surface must be clean, sound and dry prior to application.
- C. Pre-fill surface irregularities, holes and cracks in accordance with manufacturer's recommendations.

3.3 MIXING

- A. Comply with manufacturer's instructions for mixing procedures.
- B. Pre-mix each component before every batch to ensure uniformity.
- C. Carefully measure and mix the components together.

3.4 INSTALLATION

- A. Follow manufacturer's written instructions.
- B. Apply coating in accordance with manufacturer's instruction to a total thickness depending upon the agreed to requirements of the installation.
- C. Apply each coat at manufacturer's recommended coverage to provide uniform, dense surface.
- D. Allow proper cure time for each installation step.

- E. Allow the finished system to cure for a minimum of 1 full day from completion before putting into service.

END OF SECTION

SECTION 101423 – EXTERIOR PANEL SIGNAGE

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. Panel signs.
 - 2. Room-identification signs.

1.3 DEFINITIONS

- A. Accessible: In accordance with the accessibility standard.

1.4 COORDINATION

- A. Furnish templates for placement of sign-anchorage devices embedded in permanent construction by other installers.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For panel signs.
 - 1. Include fabrication and installation details and attachments to other work.
 - 2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
 - 3. Show message list, types, graphic elements, including raised characters and Braille, and layout for each sign at least half size.
- C. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.
 - 1. Include representative Samples of available types and graphic symbols.
- D. Sign Schedule: For each type of sign assembly, use same designations indicated on Drawings or specified.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and manufacturer.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For signs to include in maintenance manuals.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer of products.

1.9 FIELD CONDITIONS

- A. Field Measurements: Verify locations of anchorage devices embedded in permanent construction by other installers by field measurements before fabrication and indicate measurements on Shop Drawings.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering.
 - b. Deterioration of embedded graphic image.
 - c. Separation or delamination of sheet materials and components.
 - 2. Warranty Period: Five years from date of Final Acceptance.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Thermal Movements: For exterior signs, allow for thermal movements from ambient and surface temperature changes and exposure to the weather..
 - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- B. Accessibility Standard: Comply with applicable provisions in ICC A117.1 for signs.

2.2 SIGNS

- A. Panel Sign Type A, H.2, D.3: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
 - 1. Panel signage shall comply with the WTCC Interior Signage Standards. Provide products from, but not limited to, one of the manufacturers listed below:
 - a. Avalis Wayfinding Solutions.
 - b. Modulex Carolinas
 - c. Best Sign Systems, Inc.

- d. Mohawk Sign Systems.
- e. Apco.
- 2. Color: To be selected by owner from WTCC Signage Standard.
- 3. Size: See Drawings.
- 4. Mounting: Surface mounted to wall exterior masonry wall.
- 5. Text and Typeface: Accessible raised characters and Braille, and typeface as defined by WTCC Signage Standards. See drawing A001 for Signage Type Details
 - a. Type A- Room ID panel sign (ELEC\IT & UTILITY)
 - 1) Material: Acrylic
 - 2) Copy Font: Avenir Book
 - 3) Copy Size: 5/8"
 - 4) Copy Position: Left
 - 5) Square Corner
 - b. Type D.3 -Panel sign – (Unisex Restroom/Shower)
 - 1) Material: Acrylic
 - 2) Copy Font: Avenir Book
 - 3) Copy Size: 5/8"
 - 4) Copy Position: Left
 - 5) Square Corner
 - 6) Symbol: Accessible Toilet, Shower (where applicable)
 - c. Type H.2 -Flag Sign, 2 sided- (provide 1 each for symbols listed below)
 - 1) Material: Acrylic
 - 2) Copy Font: none
 - 3) Copy Size: none
 - 4) Copy Position: none
 - 5) Square Corner
 - 6) Symbol:
 - a) Fire Extinguisher pictogram
 - b) AED pictogram
 - c) First Aid Kit pictogram

2.3 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signage, noncorrosive and compatible with each material joined, and complying with the following:
 - 1. Use concealed fasteners and anchors unless indicated to be exposed.
 - 2. Inserts: Furnish inserts to be set by other trades into concrete or masonry work.

2.4 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to the requirements indicated.
 - 1. Preassemble signs and assemblies in the shop to the greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
 - 2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
 - 3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
 - 4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.

5. Internally brace signs for stability and for securing fasteners.
 6. Provide rebates, lugs, and brackets necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.
- B. Subsurface-Engraved Graphics: Reverse engrave back face of clear face-sheet material. Fill resulting copy with manufacturer's standard enamel. Apply opaque manufacturer's standard background color coating over enamel-filled copy.
- C. Shop- and Subsurface-Applied Vinyl: Align vinyl film in final position and apply to surface. Firmly press film from the middle outward to obtain good bond without blisters or fishmouths.
- D. Signs with Changeable Message Capability: Fabricate signs to allow insertion of changeable messages as follows:
1. For snap-in changeable inserts beneath removable face sheet, furnish one suction or other device to assist in removing face sheet. Furnish initial changeable insert. Furnish two blank inserts for each sign for Owner's use.
 2. For slide-in changeable inserts, fabricate slot without burrs or constrictions that inhibit function. Furnish initial changeable insert. Furnish two blank inserts for each sign for Owner's use.
 3. For frame to hold changeable sign panel, fabricate frame without burrs or constrictions that inhibit function. Furnish initial sign panel.

2.5 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical 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.
- C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.
- D. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

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 signage work.
- B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.
- C. Verify that anchor inserts are correctly sized and located to accommodate signs.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
 - 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 - 2. Install signs so they do not protrude or obstruct according to the accessibility standard.
 - 3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
- B. Room-Identification Signs and Other Accessible Signage: Install in locations on walls as indicated.

3.3 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION

SECTION 102600 - WALL AND DOOR PROTECTION

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. Cart guards.
 - 2. Corner guards.
 - 3. Abuse-resistant wall coverings.
- B. Related Requirements:
 - 1. Section 087100 "Door Hardware" for metal and plastic protective trim units, according to BHMA A156.6, used for armor, kick, mop, and push plates.
 - 2. Section 092900 - "Gypsum board" for wall finish.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For each type of wall and door protection showing locations and extent.
 - 1. Include plans, elevations, sections, and attachment details. Show handrail design and support spacing required to withstand structural loads.
- C. Samples for Initial Selection: For each type of impact-resistant wall-protection unit indicated, in each color and texture specified.
 - 1. Include Samples of accent strips and accessories to verify color selection.
- D. Samples for Verification: For each type of exposed finish on the following products, prepared on Samples of size indicated below:

1. Cart Guards: 12 inches long. Include examples of joinery, corners, end caps, top caps, and field splices.
2. Corner Guards: 12 inches long. Include example top caps.
3. Abuse-Resistant Wall Covering: 6 by 6 inches square.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of handrail.
- B. Material Certificates: For each type of exposed plastic material.
- C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of wall and door protection product to include in maintenance manuals.
 1. Include recommended methods and frequency of maintenance for maintaining best condition of plastic covers under anticipated traffic and use conditions. Include precautions against using cleaning materials and methods that may be detrimental to finishes and performance.

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. Cart Guard Covers: Full-size plastic covers of maximum length equal to 5 percent of each type, color, and texture of cover installed, but no fewer than two, 96-inch- long units.
 2. Corner-Guard Covers: Full-size plastic covers of maximum length equal to 5 percent of each type, color, and texture of cover installed, but no fewer than two, 48-inch- long units.
 3. Mounting and Accessory Components: Amounts proportional to the quantities of extra materials. Package mounting and accessory components with each extra material.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store wall and door protection in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1. Maintain room temperature within storage area at not less than 70 deg F during the period plastic materials are stored.
2. Keep plastic materials out of direct sunlight.
3. Store plastic wall- and door-protection components for a minimum of 72 hours, or until plastic material attains a minimum room temperature of 70 deg F.
 - a. Store corner-guard covers in a vertical position.
 - b. Store Cart guard covers in a horizontal position.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of wall- and door-protection units that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Structural failures including detachment of components from each other or from the substrates, delamination, and permanent deformation beyond normal use.
 - b. Deterioration of metals, metal finishes, plastics, and other materials beyond normal use.
 2. Warranty Period: Five years from date of Final Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain wall- and door-protection products of each type from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Surface Burning Characteristics: Comply with ASTM E 84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Flame-Spread Index: 25 or less.
 2. Smoke-Developed Index: 450 or less.
- B. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1.

2.3 CRASH RAIL (CR-1); See Finish Legend

- A. Cart Guards Heavy-duty, PVC-free assembly consisting of continuous snap-on plastic cover installed over concealed retainer; designed to withstand impacts.
1. Manufacturers: Basis-of-Design Products - Subject to compliance with requirements, provide Korogard Wall Protection Systems, or comparable product by one of the following:
 - a. InPro Corporation (IPC).
 - b. Acrovyn
 2. Cover: Crash Rail mounted over continuous aluminum retainer.
 - a. Profile: high-impact vinyl acrylic extrusion locked in place.
 - 1) Dimensions: Nominal 4 inches high by 7/8" inch deep.
 - 2) Surface: Uniform.
 - 3) Clearance: Flush with wall
 - b. Color and Texture: As selected by Architect from manufacturer's full range. C40F smooth finish.
 3. Continuous Retainer: Minimum 0.080-inch- thick, one-piece, extruded aluminum.
 4. Retainer Clips: Manufacturer's standard impact-absorbing clips designed for heavy-duty performance.
 5. Bumper: Continuous, resilient bumper cushion(s).
 6. End Caps and Corners: Prefabricated, injection-molded plastic; matching color cover; field adjustable for close alignment with snap-on cover.
 7. Accessories: Concealed splices and mounting hardware.
 8. Mounting: Surface mounted directly to wall.
 9. Length: Continuous run; 4" gap at doorways and corners.

2.4 CORNER GUARDS

- A. Corner Guard (CG-1), See Finish Legend: Surface-Mounted Metal Corner Guards. Fabricated as one piece from formed or extruded metal with formed edges; with 90- or 135-degree turn to match wall condition.
1. Manufacturers: Basis-of-Design Products - Subject to compliance with requirements, provide Korogard Wall Protection Systems, or comparable product by one of the following:
 - a. InPro Corporation (IPC).
 - b. Acrovyn

2. Material: Aluminum
 - a. Thickness: Minimum 0.375 inch
 - b. Finish: See Finish Legend
 3. Wing Size: Nominal 1 1/2 by 1 1/2 inches
 4. Mounting: Installed by Gypsum wallboard contract liquid nails.
- B. Corner Guards (CG-2 and CG-3), See Finish Legend: Surface-Mounted Vinyl Corner Guards.
- Retain "Manufacturers" Subparagraph below and list of manufacturers to require products from manufacturers listed or a comparable product from other manufacturers.
1. Manufacturers: Basis-of-Design Products - Subject to compliance with requirements, provide Korogard Wall Protection Systems, or comparable product by one of the following:
 - a. InPro Corporation (IPC).
 - b. Acrovyn
 2. Material: Vinyl
 - a. Thickness: Minimum 0.375 inch
 - b. Finish: See Finish Legend
 3. Wing Size: Nominal 3 by 3 inches
 4. Mounting: Installed by Gypsum wallboard contract liquid nails.
- C. Corner Guard (CG-4), See Finish Legend: Surface-Mounted Metal Corner Guards with exposed fasteners. Fabricated as one piece from formed or extruded metal with formed edges; with 90- or 135-degree turn to match wall condition.
1. Manufacturers: Basis-of-Design Products - Subject to compliance with requirements, provide Korogard Wall Protection Systems, or comparable product by one of the following:
 - a. InPro Corporation (IPC).
 - b. Acrovyn
 2. Material: Stainless-steel sheet, Type 304.
 - a. Thickness: Minimum 0.375 inch
 - b. Finish: See Finish Legend
 3. Wing Size: Nominal 3 by 3 inches

4. Mounting: Installed by Gypsum wallboard contract with exposed fasteners.

2.5 ABUSE-RESISTANT WALL COVERINGS

- A. Abuse-Resistant Sheet Wall Covering (WP-1), See Finish Legend: Fabricated from semirigid, plastic sheet wall-covering material.
 1. Manufacturers: Basis-of-Design Products - Subject to compliance with requirements, provide P3TEC or comparable product by one of the following:
 - a. Korogard Wall Protection Systems; a division of RJF International Corporation.
 - b. MDC Interior Solutions
 2. Size: As indicated on drawings.
 3. Color and Texture: See Finish Legend
 4. Height: As indicated on drawings.
 5. Trim and Joint Moldings: Extruded rigid plastic that matches wall-covering color.
 6. Mounting: Adhesive.

2.6 MATERIALS

- A. Plastic Materials: Chemical- and stain-resistant, high-impact-resistant plastic with integral color throughout; extruded and sheet material as required, thickness as indicated.
- B. Polycarbonate Plastic Sheet: ASTM D 6098, S-PC01, Class 1 or Class 2, abrasion resistant; with a minimum impact-resistance rating of 15 ft.-lbf/in. of notch when tested according to ASTM D 256, Test Method A.
- C. Fasteners: Aluminum, nonmagnetic stainless-steel, or other noncorrosive metal screws, bolts, and other fasteners compatible with items being fastened. Use security-type fasteners where exposed to view.
- D. Adhesive: As recommended by protection product manufacturer.
 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.

2.7 FABRICATION

- A. Fabricate wall and door protection according to requirements indicated for design, performance, dimensions, and member sizes, including thicknesses of components.
- B. Curved Panels: Preform curved semirigid, abuse-resistant sheet wall covering in factory for radius and sheet thickness as follows:
 - 1. Sheet Thickness of 0.040 Inch: 24-inch radius.
 - 2. Sheet Thickness of 0.060 Inch: 36-inch radius.
- C. Factory Assembly: Assemble components in factory to greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling.
- D. Quality: Fabricate components with uniformly tight seams and joints and with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.

2.8 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. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances, fire rating, and other conditions affecting performance of the Work.
- B. Examine walls to which wall and door protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.
 - 1. For wall and door protection attached with adhesive, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Complete finishing operations, including painting, before installing wall and door protection.
- B. Before installation, clean substrate to remove dust, debris, and loose particles.

3.3 INSTALLATION

- A. Installation Quality: Install wall and door 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, splice aluminum retainers and plastic covers at different locations along the run, but no closer than 12 inches apart.
 - 3. Adjust end and top caps as required to ensure tight seams.
- D. Abuse-Resistant Wall Covering: Install top and edge moldings, corners, and divider bars as required for a complete installation.

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



SECTION 102800-TOILET, BATH, AND LAUNDRY 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. Public-use washroom accessories.
 - 2. Custodial accessories.
 - 3. Public-use shower room accessories.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include the following:
 - 1. Construction details and dimensions.
 - 2. Anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
 - 3. Material and finish descriptions.
 - 4. Features that will be included for Project.
 - 5. Manufacturer's warranty.
- B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
 - 1. Identify locations using room designations indicated.
 - 2. Identify products using designations indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For toilet and bath accessories to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Source Limitations: For products listed together in the same Part 2 articles, obtain products from single source from single manufacturer.
- 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.

1.7 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.

1.8 WARRANTY

- A. Special Mirror Warranty: Manufacturer's standard form in which manufacturer agrees to replace mirrors that develop visible silver spoilage defects and that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 15 years from date of Final Acceptance.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, 0.031-inch (0.8-mm) minimum nominal thickness unless otherwise indicated.
- B. Brass: ASTM B 19, flat products; ASTM B 16/B 16M, rods, shapes, forgings, and flat products with finished edges; or ASTM B 30, castings.
- C. Steel Sheet: ASTM A 1008/A 1008M, Designation CS (cold rolled, commercial steel), 0.036-inch (0.9-mm) minimum nominal thickness.
- D. Galvanized-Steel Sheet: ASTM A 653/A 653M, with G60 (Z180) hot-dip zinc coating.
- E. Galvanized-Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
- F. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.
- G. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).
- H. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.
- I. ABS Plastic: Acrylonitrile-butadiene-styrene resin formulation.

PUBLIC-USE WASHROOM ACCESSORIES

- J. Grab Bar 102800.01:
 - 1. Basis-of-Design Product: Bobrick, B-6897
 - 2. Mounting: Flanges with concealed fasteners.
 - 3. Material: Stainless steel, 0.05 inch (1.3 mm) thick.
 - a. Finish: Smooth, No. 4 finish (satin)
 - 4. Outside Diameter: 1-1/2 inches (38 mm).
 - 5. Configuration and Length: As indicated on Drawings (54 x 42 x 1.25).
- K. Grab Bar 102800.02:
 - 1. Basis-of-Design Product: Bobrick, B-6806 (18")
 - 2. Mounting: Flanges with concealed fasteners.
 - 3. Material: Stainless steel, 0.05 inch (1.3 mm) thick.
 - a. Finish: Smooth, No. 4 finish (satin)
 - 4. Outside Diameter: 1-1/2 inches (38 mm).
 - 5. Configuration and Length: As indicated on Drawings.
- L. Toilet Tissue Dispenser 102800.03: OFOI
- M. Paper Towel Dispenser 102800.05: OFOI
- N. Liquid-Soap Dispenser 102800.07: OFOI
- O. Sanitary-Napkin Disposal Unit 102800.08: OFOI
- P. Seat-Cover Dispenser 102800.09: OFOI
- Q. Mirror Unit 102800.16:
 - 1. Basis-of-Design Product: Bobrick B-292 2440
 - 2. Frame: Welded stainless steel, satin finish with shelf
 - a. Corners: Manufacturer's standard
 - b. Size: 24" wide x 40" tall
 - 3. Tempered glass mirror
 - 4. Hangers: Produce rigid, tamper- and theft-resistant installation, using method indicated below.
 - a. One-piece, galvanized-steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.
 - b. Wall bracket of galvanized steel, equipped with concealed locking devices requiring a special tool to remove.

2.2 PUBLIC-USE SHOWER ROOM ACCESSORIES

- A. Robe Hook 102800.10:
 - 1. Basis-of-Design Product: Bobrick B-6727 Dbl Robe Hook
 - 2. Mounted: Surface
 - 3. Material: Stainless steel, satin finish
- B. Shower Curtain Rod 102800.12:
 - 1. Basis-of-Design Product: Bobrick; B-6047
 - 2. Description: 1-1/4" (32mm) OD; fabricated from nominal 18 gauge (1.2mm) stainless steel tubing with satin finish.

-
3. Mounting Flanges: Stainless-steel flanges designed for exposed fasteners.
 4. Finish: No. 4 (satin).
- C. Shower Curtain 102800.12:
1. Basis-of-Design Product: Bobrick; B-204-2
 2. Size: Minimum 6 inches (152 mm) wider than opening by 72 inches (1828 mm) high.
 3. Material: Nylon-reinforced vinyl, minimum 10 oz. (284 g) or 0.008-inch-(0.2-mm-)thick vinyl, with integral antibacterial agent.
 4. Color: White
 5. Grommets: Corrosion resistant at minimum 6 inches (152 mm) o.c. through top hem.
 6. Shower Curtain Hooks: Stainless-steel, spring wire curtain hooks with snap fasteners, sized to accommodate specified curtain rod. Provide one hook per curtain grommet.
- D. Folding Shower Seat 102800.13:
1. Basis-of-Design Product: Bobrick; Model B-5181
 2. Seat: Phenolic or polymeric composite of slat-type or one-piece construction
 3. Mounting Mechanism: Stainless steel, No. 4 finish (satin).
 4. Dimensions: As indicated.
- E. Grab Bar 102800.19:
1. Basis-of-Design Product: Bobrick, B-6861
 2. Mounting: Flanges with concealed fasteners.
 3. Material: Stainless steel, 0.05 inch (1.3 mm) thick.
 - a. Finish: Smooth, No. 4 finish (satin)
 4. Outside Diameter: 1-1/2 inches (38 mm).
 5. Configuration and Length: As indicated on Drawings (16 x 31 x 1.5).

2.3 CUSTODIAL ACCESSORIES

- A. Mop and Broom Holder 102800.15:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Specialties, Inc.
 - b. Bobrick Washroom Equipment, Inc.
 - c. Bradley Corporation
 2. Basis-of-Design Product: Bradley 9954.
 3. Description: Mop and broom holders.
 4. Length: 36 inches.
 5. Mop/Broom Holders: Four, spring-loaded, rubber hat, cam type.
 6. Material and Finish: Stainless steel, No.4 finish (satin).

2.4 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

- A. Install accessories according to 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.
- B. Grab Bars: Install to withstand a downward load of at least 250 lbf (1112 N), when tested according to ASTM F 446.

3.2 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Remove temporary labels and protective coatings.
- C. Clean and polish exposed surfaces according to manufacturer's written recommendations.

END OF SECTION

SECTION 10 43 13 - DEFIBRILLATOR CABINETS

PART 1 - GENERAL

1.1 Summary

- A. Section Includes
 - 1. Exterior rated (outdoor) automatic external defibrillators (AED) cabinet.

PART 2 - PRODUCTS

2.1 AED CABINET

- A. Cabinet Type: Surface-mounted cabinet with strobe and alarm.
 - 1. Basis-of-Design Product: AIVIA 200 is an indoor / outdoor, Alarmed AED cabinet by AED.US
- B. Alarm:
 - 1. Visual Alarm:
 - a. Color: White
 - b. Alarm activates and deactivates the strobe.
 - 2. Audio Alarm:
 - a. Speaker rated to transmit a siren sound of 85-120dB
 - b. Alarm Circuitry: Activated upon opening cabinet door.
 - 3. Accessories
 - a. Heating / cooling fan (activated by a temperature sensor with configurable thresholds)
- C. Power Requirements for Alarm Board, Siren and LED:
 - 1. Provide a dedicated 120V, 20A duplex receptacle.

2.2 AUTOMATED EXTERNAL DEFIBRILLATORS (AEDs) (Owner Provided)

- A. Basis-of-Design Product: WTCC Standard AED

2.3 AED SIGNAGE

- A. Signage
 - 1. Coordinate with WTCC signage standard; see 101423 Panel Signage for Flag Sign

PART 3 - EXECUTION

3.1 INSTALLATION

- A. AED cabinets: Fasten cabinets to structure, square, and plumb. Mount cabinet at 48" to the center of the door handle from the finished floor.
- B. Coordinate the compatibility of the cabinet with the owner-provided AED before purchase.

END OF SECTION

SECTION 10 43 16 – FIRST AID CABINET & KIT

PART 1 - GENERAL

- 1.1 Summary
 - A. Section Includes
 - 1. Exterior-rated (outdoor) first aid cabinet and kit.

PART 2 - PRODUCTS

- 2.1 First Aid Cabinet-Life Safety Station
 - A. Cabinet Type: Polycarbonate Life Safety Station Cabinet
 - 1. Basis-of-Design Product: Life Safety Station by AED.US (SKU; LSSO)
 - 2. Polycarbonate cabinet with clear polycarbonate front glass with air and water-tight seal
 - 3. Dimensions: 24" height X 21" width X 9.5" depth (external).
 - 4. Accessories
 - a. Integrated mounting flanges
 - b. Adjustable shelves
 - c. Two polycarbonate latches
 - d. Labeled on 3 sides with "LIFE SAFETY STATION"
- 2.2 First Aid Trauma Kit – 100 Person First Aid Kit
 - A. Provide the equivalent of the WTCC Standard 100-Person Industrial First Aid Kit
 - 1. Provide red nylon bag that is sized to fit into cabinet above.
 - 2. ANSI/ISEA Z308.1-2015 Compliant; Class A+ Type I & II; Meets or exceeds Federal OSHA Regulation 1910.151(b)
- 2.3 Signage
 - 1. Coordinate with WTCC signage standard; see 101423 Panel Signage for Flag Sign

PART 3 - EXECUTION

- 3.1 INSTALLATION
 - A. Fasten cabinets to structure, square, and plumb. Mount cabinet at 48" to the center of the door handle from the finished floor.

END OF SECTION

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.
 - 2. Emergency Key Access Box
- 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 recessed, semi-recessed, or surface-mounting 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.

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. Basis of Design: HDOC-Heavy Duty Outdoor Fire Extinguisher Cabinets by Safety One Industries
 - 1) Model:HDOC-20-SS
 - b. Fire-End & Croker Corporation.
 - c. Guardian Fire Equipment, Inc.
 - d. JL Industries, Inc.; a division of the Activar Construction Products Group.
 - e. Larsens Manufacturing Company.
 - f. Modern Metal Products, Division of Technico Inc.
 - g. Nystrom, Inc.
 - h. Potter Roemer LLC.
- B. Cabinet Construction: Nonrated.
- C. Cabinet Material: Stainless-steel sheet.
- D. Surface-Mounted Cabinet: Cabinet box fully exposed and mounted directly on wall with no trim.
- E. Door Material: Stainless-steel sheet.
- F. Door Style: Fully glazed panel with frame.
- G. Door Hardware: weather resistive gasketing, stainless steel handle with 2 roller ball catches and safety lock.
- H. Continuous hinges in subparagraph below are most common. Concealed hinges are used for flush panel doors. Pivots are sometimes used for fully glazed, frameless acrylic doors; verify availability with manufacturers.
- I. Provide full length stainless steel piano hinge.
- J. Accessories:
 - 1. Door Lock: Cam lock that allows door to be opened during emergency by pulling sharply on door handle with a red "Pull Firmly to Open" decal.
 - 2. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location.
 - 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.

2.4 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 EMERGENCY KEY ACCESS BOX

- A. Provide emergency access box as manufactured by the Knox Company, as required by the local Fire Marshal. Provide Knox-Box recessed mount 4400 Series, nominal 7"W x 7"H x 5"D, with recessed mounting kit. Provide manufacturer's polyester powdercoat finish in black color. No substitutions will be considered. Coordinate installation at entry gate on Rescuer Road in accordance with the local Fire Marshal. Contact Knox Company: www.knoxbox.com
 1. NOTE: COORDINATE TYPE AND STYLE WITH LOCAL JURISDICTION coordinate installation and attachment to gate assembly.

2.6 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 proceed with installation only after unsatisfactory conditions have been corrected.

3.2 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.
- C. Identification:
 - 1. Apply vinyl lettering at locations indicated. Provide projecting v-bend sign mounted above cabinet.

3.3 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

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.
 - 1. Provide fire extinguishers approved, listed, and labeled by FM Global.

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 a 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

SECTION 210210 – FIRE SUPPRESSION SUMMARY OF WORK

Engineer of Record for fire suppression work is Kevin R. Allen, PE, Salas O'Brien, 702 Oberlin Road, Suite 300, Raleigh, NC 27605. 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.



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

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.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END SECTION 210510

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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

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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 $\pm 3-2-3\%$ 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.

1 **ADJUSTING AND CLEANING**

2
3 Adjust faces of meters and gages to proper angle for best visibility.
4

5 Clean windows of meters and gages and factory-finished surfaces. Replace cracked or broken windows, repair any
6 scratched or marred surfaces with manufacturer's touch-up paint.
7

8
9 **END OF SECTION 210521**

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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.

Hangers, struts, floor clamps, all-thread rod 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.

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

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		

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.

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," for sprinkler systems, which have been approved by the authority having jurisdiction.

Hydraulic Calculations are not required. System is for training purposes only.

Shop Drawings Review: The A/E has primary responsibility for review and approval of fire suppression system shop drawings and shall determine compliance with applicable codes and standards and the project contract documentation. However, the contractor shall also send the required amount of copies of the shop drawings to the local AHJ for additional review. Once all comments are resolved and approved by the A/E, and local AHJ the contractor can begin work.

Test Reports and Certificates: Include "Contractor's Material & Test Certificate for Aboveground Piping" as described in NFPA 13.

1 **SYSTEM(S) DESCRIPTION**

2
3 Provide standpipe and sprinkler water-based fire suppression systems for training as follows:

4
5 Sprinkler system shall be comprised of open element sprinklers attached to a branch line controlled by a ball valve for
6 operation. Training Tower system shall also be equipped with alarm valve and water motor gong for training
7 purposes.

8
9 Standpipe system shall consist of 2½" hose valves, piping and allied equipment for use by fire departments and those
10 trained in handling heavy fire streams. System shall be charged through FDC and is designed to contain water only
11 when the system is being utilized.

12
13
14 **DESIGN CRITERIA AND PERFORMANCE REQUIREMENTS**

15
16 Fire Protection design drawings issued by the A/E shall be considered as preliminary design documents that
17 establish the performance requirements and design criteria for fire suppression sprinkler and/or standpipe systems.
18 **Responsibility for design of fire suppression sprinkler and/or standpipe system(s), including comprehensive**
19 **engineering analysis by a qualified professional engineer or a NICET Certified Level III technician, using**
20 **performance requirements and design criteria hereinafter specified, is delegated to the Contractor.** When
21 prepared in accordance with approved design standards by a professional engineer, documents shall be sealed and
22 signed. Since NICET does not authorize seals or stamps for Technicians, documents prepared in accordance with
23 approved design standards shall bear the signature, date, NICET certification title and number of the Technician
24 taking responsibility for the work.

25
26 Piping System and Component Working Pressure: Standard pressure sprinkler system components, listed for at
27 least 175 psig.

28
29
30 **PART 2 - PRODUCTS**

31
32
33 **PIPE AND FITTINGS**

34
35 Provide pipe and tube of type, joint type, grade, size and weight (wall thickness or Class) indicated for each service.
36 Where type, grade or class is not indicated, provide proper selection as determined by Installer for installation
37 requirements, and comply with governing regulations and industry standards.

38
39 Provide factory-fabricated fittings of type, materials, grade, class and pressure rating indicated for each service and
40 pipe size. Provide sizes and types matching pipe, tube, valve or equipment connection in each case. Where not
41 otherwise indicated, comply with governing regulations and industry standards for selections, and with pipe
42 manufacturer's recommendations where applicable.

43
44 *Pipe and fittings shall be listed for use as fire sprinkler piping.*

45
46
47 **STEEL PIPE AND FITTINGS**

48
49 All steel standpipe and sprinkler pipe shall include FM-approved MIC inhibiting coating.

50
51 Steel pipe shall comply with ASTM A53, Type E, Grade B for 4" and larger and ASTM A53, Type F, Grade A for 3"
52 and smaller, galvanized and galvanized fittings.

53
54 Provide Schedule 40 steel pipe, sizes 2" NPS and smaller. Provide no less than Schedule 10 steel pipe, sizes 2-1/2"
55 NPS and larger. Schedule 10 steel pipe is permitted to be used **only** with listed rolled or swaged groove joints.
56 **Schedule 5 pipe in any size is prohibited.**

57
58 All fittings must be listed or approved for the specific pipe and type of system they are used on. For gasketed fittings,
59 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.

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.

Indicator Posts with Gate Valves: Size 4" and larger shall have rating of 175 psi WWP or greater with bronze trim or resilient rubber encapsulated wedge. Body and bonnet are to be of cast iron alloy ASTM A-126 Class B with bonnet incorporating indicator post mounting flange. If of resilient wedge design, interior of valve is to be epoxy-coated. Ends to be flanged Class 125 or mechanical joint. Upright indicator post to be adjustable for bury depth required. Valves and posts to be Underwriters Laboratories listed and Factory Mutual Approved. Where applicable, valves to be in compliance with ANSI/MSS-SP70. Valves shall be provided with a tamper switch listed for exterior application.

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.

Wet-Pipe Alarm Check Valve: 175 psig working pressure, designed for horizontal or vertical installations, and have cast iron, flanged inlet and outlet, bronze grooved seat with "O" ring seals, single hinge pin and latch design. Provide trim sets for bypass, drain, electric sprinkler alarm switch, pressure gages, precision retarding chamber, drip cup assembly piped without valves separate from main drain line, and fill line attachment with strainer.

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".

Sprinkler Head Finishes: Provide heads with the following finishes:

Upright: Exposed to view; rough bronze finish for heads in unfinished spaces and not exposed to view.

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.

FIRE HOSE VALVES

Hose Outlet Valves for Class I Standpipes: 300 psig, 2-1/2 inch, polished chrome plated, brass angle valve with external threads having the NH standard thread, for the 2-1/2 inch valve, as specified in NFPA 1963. Provide valve with chrome plated cap and chain and spanner wrench for removal of outlet cap.

FIRE DEPARTMENT CONNECTIONS

Wall Type Fire Department Connection: Locking Storz 5" inlet x 4" female NPT outlet, 30° angle pattern adapter, with blind cap with lock and securing wire or chain, hard coated aluminum construction. Furnish with polished chrome plated cast brass wall identification plate lettered "AUTO SPKR" or "STANDPIPE" or "DRY STANDPIPE" or "AUTO SPKR STANDPIPE" in raised letters. Connection shall be 6625 as manufactured by Guardian Fire Equipment or equal by Potter Roemer, FPPI or Elkhart Brass Mfg. Co. Connection shall comply with requirements of the local fire department.

ALARM DEVICES

Water-Motor Gongs: 10 inch diameter cast aluminum gong, with factory-finish in red enamel; Pelton Wheel type operator with nylon shaft bearings, and shaft length and sleeve to suit wall thickness and construction; 3/4 inch inlet and 1 inch drain.

PART 3 - EXECUTION

SPRINKLER APPLICATIONS

Sprinklers installed in areas without ceilings shall be upright type.

PIPING APPLICATIONS

Piping shall be galvanized steel.

PIPING INSTALLATION

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.

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.

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.

Wet-Pipe Alarm Check Valves: Install valves in the vertical position, in proper direction of flow including the bypass check valve and retard chamber drain line connection. Install valve trim in accordance with the valve manufacturer's appropriate trim diagram. Test valve for proper operation.

Hose Outlet Valves: Install 2-1/2 inch hose outlet valves at each standpipe outlet for hose connections. Orient valve outlet downward at a 45° angle from the horizontal unless noted otherwise on the drawings.

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.

FIRE DEPARTMENT CONNECTION INSTALLATION

Install automatic drip valves at the check valve on the fire department connection to the mains.

Install mechanical sleeve seal at pipe penetration in outside walls.

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.

Flush, test, and inspect standpipe systems in accordance with NFPA 14.

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.

1 Identify each valve and control with a prominent engraved phenolic or stamped metal placard.

2
3 Any such devices that are behind access doors or panels must also have their location made
4 known by an appropriate placard on the means of access.

5
6 The contractor shall thoroughly inspect the completed system to assure compliance with this document, project plans
7 and specs, and applicable Codes and Standards. This shall include an operational test of each waterflow alarm
8 switch and all system supervisory devices (valve tamper, hi-low air pressure, pump status, etc) **in coordination with**
9 **the fire alarm system subcontractor.**

10
11 Pressure tests shall be done with all sprinkler heads installed. System shall be tested in accordance with NFPA 13 or
12 NFPA 14, as applicable. Any leak shall be repaired by remaking of leaking joint and the system shall be retested until
13 no leaks occur.

14
15 Where an existing sprinkler system is being expanded or renovated, the contractor shall be responsible for the
16 integrity of all new piping plus existing piping within three feet of new or renovation work.

17
18 Prior to the final inspection by the AHJ and/or the owner's representative, complete and submit three (3) copies each
19 of the NFPA-required certificates for aboveground and underground piping.

20
21
22 **EXTRA MATERIALS**

23
24 Furnish to Owner two (2) valve wrenches for each type of sprinkler head installed.

25
26 Furnish extra sprinkler heads of each style included in the project, per the following table. Furnish each style with its
27 own sprinkler head cabinet and special wrenches as specified in this Section.

28
29

30 Less than 20 sprinklers	2
31 21 to 100 sprinklers	4
32 101 to 299 sprinklers	8
33 300 to 1000 sprinklers	12
34 Over 1000	24

35
36

37 **OWNER INSTRUCTION AND TRAINING**

38
39 Provide Owner instruction and training in accordance with Section 019926.

40
41
42 **END OF SECTION 211000**

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SECTION 220210 – PLUMBING SUMMARY OF WORK

Engineer of Record for plumbing work is Kevin R. Allen, PE, Salas O'Brien, 702 Oberlin Road, Suite 300, Raleigh, NC 27529. 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.



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
221316	Sanitary Waste and Vent Piping
223300	Electric Domestic Water Heaters
224000	Plumbing Fixtures

END OF SECTION 220210

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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.

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

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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 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 be described by the Drawings.

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

1 **GENERAL**

2
3 Coordinate the exact location of all equipment disconnects with Divisions 26-28 to ensure that disconnects are
4 located within sight of plumbing equipment.

5
6 Extend power wiring circuits from load side of termination points provided under Divisions 26-28 to each item of
7 plumbing equipment requiring electrical power. All wiring shall be installed in raceway in compliance with Division 26.
8 Utilize flexible metallic conduit for weatherproof for outdoor locations. Provide all necessary clamps, fitting,
9 connectors, raceways, circuit conductors, etc., for a completely operational system.

10
11
12 **INSTALLATION OF CIRCUIT AND MOTOR DISCONNECTS**

13
14 Install disconnects as indicated, complying with manufacturer's written instructions, applicable requirements of NEC,
15 NEMA, and NECA's "Standard of Installation," and in accordance with recognized industry practices.

16
17 Coordinate placement of disconnects with electrical raceway and cable work, as necessary for proper interface.
18 Coordinate exact location of disconnects with equipment electrical connection point.

19
20 Locate disconnects so that they are readily accessible after all project elements are installed. Location
21 selected for disconnects must permit complete opening of the door or cover to the maximum amount
22 permitted by the design of the switch enclosure.

23
24 Install disconnects for use with motor-driven appliances and motors within sight of the controllers, as indicated on the
25 Drawings. In addition, each motor shall be provided with an approved disconnecting device within sight of the
26 respective equipment as required by the NEC even though not specifically indicated on the Drawings. Disconnects
27 installed for use with controllers may serve as the disconnecting means for the motor if it is in sight from the motor
28 location and the driven machinery location.

29
30 **GROUNDING**

31
32 Provide equipment grounding connections, sufficiently tight to assure a permanent and effective ground.

33
34
35 **FIELD QUALITY CONTROL**

36
37 Subsequent to completion of installation of disconnects and motor starters, energize circuitry and demonstrate
38 capability and compliance with requirements. Where possible, correct malfunctioning units at project site, then retest
39 to demonstrate compliance; otherwise remove and replace with new units and retest.

40
41
42 **OWNER INSTRUCTION AND TRAINING**

43
44 Provide Owner instruction and training in accordance with Section 019926.

45
46
47 **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

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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.

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 and in Training Tower: 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.

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.

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

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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
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

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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-Contractor 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

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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.**

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.

1 Insulate with mineral wool insulation, 1-1/2" thick for pipe sizes up to and including 1", 2" thick for pipe sizes
2 1-1/4" through 2", and 2-1/2" thick for pipe sizes over 2".
3

4 Exception: Omit insulation on chrome-plated exposed piping (except for handicapped fixtures), air
5 chambers, unions, strainers, check valves, balance cocks, flow regulators, drain lines from water coolers,
6 drainage piping located in crawl spaces or tunnels, buried piping, fire protection piping, and pre- insulated
7 equipment.
8
9

10 **GENERAL PIPING INSULATION INSTALLATION REQUIREMENTS**

11

12 Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids
13 throughout the length of piping including fittings, valves, and specialties.
14

15 Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe
16 system as specified in insulation system schedules.
17

18 **For Classification Type 3A piping, do not insulate valves, strainers, unions, and other accessories.**
19

20 Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not
21 corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
22

23 Install insulation with longitudinal seams at top and bottom of horizontal runs.
24

25 Install multiple layers of insulation with longitudinal and end seams staggered.
26

27 Do not weld pins, clips, or other insulation attachment devices to piping, fittings, and specialties.
28

29 Keep insulation materials dry during application and finishing.
30

31 Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by
32 insulation material manufacturer.
33

34 Install insulation with least number of joints practical.
35

36 Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and
37 other projections with vapor-barrier mastic.
38

39 Install insulation continuously through hangers and around anchor attachments:
40

41 At pipe hangers and supports, protect the insulation from compression by installing cellular glass piping
42 insulation for the length of the insulation shield specified above.
43

44 Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with
45 adhesive or sealing compound recommended by insulation material manufacturer.
46

47 Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to
48 protect jacket from tear or puncture by hanger, support, and shield.
49

50 For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of
51 attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to
52 structure with vapor-barrier mastic.
53

54 Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film
55 thicknesses.
56

57 Install insulation with factory-applied jackets as follows:
58

59 Draw jacket tight and smooth.
60

61 Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket.
62

- 1 Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
2
3 Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom
4 of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along
5 edge at 2 inches o.c.
6
7 For below-ambient services, apply vapor-barrier mastic over staples.
8
9 Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to
10 maintain vapor seal.
11
12 Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to
13 pipe flanges and fittings.
14
15 Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
16
17 Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal
18 movement.
19
20 Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4
21 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
22
23

PIPING INSULATION INSTALLATION AT PENETRATIONS

24
25
26 Roof Penetrations: Install insulation continuously through roof penetrations.

27
28 Seal penetrations with flashing sealant.
29

30 For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint
31 sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications
32 tightly joined to indoor insulation ends. Seal joint with joint sealant.
33

34 Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
35

36 Seal jacket to roof flashing with flashing sealant.
37

38 Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing
39 sealant.
40

41 Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

42
43 Seal penetrations with flashing sealant.
44

45 For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint
46 sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications
47 tightly joined to indoor insulation ends. Seal joint with joint sealant.
48

49 Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
50

51 Seal jacket to wall flashing with flashing sealant.
52

53 Interior Wall, Partition, and Floor Penetrations: Install insulation continuously through walls, partitions, and floors.
54 Seal penetrations through fire-rated assemblies complying with requirements of Section 019913 for firestopping and
55 fire-resistive joint sealers.
56

INSTALLATION OF MINERAL FIBER PIPING INSULATION

57
58
59 Insulation Installation on Straight Pipes and Tubes:

60
61 Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without
62 deforming insulation materials.

- 1
2 Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier
3 mastic and joint sealant.
4
5 For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched
6 staples at 6 inches o.c.
7
8 For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs.
9 Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal
10 with vapor-barrier mastic and flashing sealant.
11
12 Insulation Installation on Pipe Flanges:
13
14 Install preformed pipe insulation to outer diameter of pipe flange.
15
16 Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe
17 insulation.
18
19 Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe
20 segments with mineral-fiber blanket insulation.
21 Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm),
22 and seal joints with flashing sealant.
23
24 Insulation Installation on Pipe Fittings and Elbows:
25
26 Install preformed sections of same material as straight segments of pipe insulation when available.
27
28 When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to
29 a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
30
31 Insulation Installation on Valves and Pipe Specialties:
32
33 Install preformed sections of same material as straight segments of pipe insulation when available.
34
35 When preformed sections are not available, install mitered sections of pipe insulation to valve body.
36
37 Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
38
39 Install insulation to flanges as specified for flange insulation application.
40

41 42 **FIELD-APPLIED INSULATION JACKET INSTALLATION** 43 44

- 45 Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints;
46 for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with
47 manufacturer's recommended adhesive. Apply two continuous beads of adhesive to seams and joints, one bead
48 under lap and the finish bead along seam and joint edge.
49
50 Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap
51 longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation
52 manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.
53
54

55 **END OF SECTION 220700**

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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 CI-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.

Exception: With A/E approval, the Contractor may utilize press connection copper fittings in lieu of wrought copper fittings with solder joints, 1/2"-4" NPS. Press copper fittings shall be fabricated of copper/copper alloy and comply with ASME B16.22. Sealing elements in fittings shall be EPDM O-rings. Fittings 2-1/2" NPS and larger shall have additional stainless steel grip rings. Fittings shall be Viega "ProPress System" fittings or equivalent.

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.

1 Gate Valves: Valves shall be Class 125 rising stem, union bonnet, solid wedge and manufactured in
2 accordance with MSS SP- 80. Body, bonnet and wedge are to be bronze ASTM B-62. Stems shall be of
3 dezincification-resistant silicon bronze ASTM B-371 or low-zinc alloy B-99, non-asbestos packing and
4 malleable or ductile iron handwheel.
5
6 Globe/Angle Valves: Valves shall be Class 125 and manufactured in accordance with MSS SP-80; body
7 and bonnet are to be of bronze ASTM B-62. Stems shall be of dezincification-resistant silicon bronze ASTM
8 B-371 or low-zinc alloy B-99, non-asbestos packing, TFE seat disc and malleable or ductile iron handwheel.
9
10 Check Valves: Valves shall be Y-pattern swing-type manufactured in accordance with MSS SP-80, Class
11 125, bronze ASTM B-62 body with TFE seat disc.
12
13 Balance Cocks: Class 125, bronze body, bronze plug, screw driver operated, straight or angle pattern.
14
15 Valves 2 1/2" and Larger: Provide with flanged ends complying with Class 150 ANSI B16.5. Working Pressure and
16 temperature shall comply with ANSI B 16.34.
17
18 Ball Valve: Valves to be rated at 150 psi SWP, 600 psi non-shock WOG, and will have 3 piece cast bronze
19 body, RPTFE seats and packing stainless steel anti-blowout stems, stainless steel ball.
20
21 Gate Valves: Valves shall be Class 125 rising stem, union bonnet, solid wedge and manufactured in
22 accordance with MSS SP-80. Body, bonnet and wedge are to be of bronze ASTM B-62. Stems shall be of
23 dezincification-resistant silicon bronze ASTM B-371 or low-zinc alloy B-99, non-asbestos packing and
24 malleable or ductile iron handwheel.
25
26 Butterfly Valves: Valves shall be full lug style manufactured in accordance with MSS SP-67 rated at least
27 200 psi non-shock cold water working pressure. Body to be cast iron or ductile iron. Valves to have
28 aluminum bronze alloy disc with EPDM rubber seat and seals or EPDM rubber encapsulated disc with
29 polymer-coated body. Stem shall be 400 series stainless and shall not have exposed stem to disc
30 fasteners.
31
32 Gate, Globe/Angle Valves: Valves to be Class 125 manufactured in accordance with MSS SP-70 (gate) or
33 MSS SP-85 (globe/angle), flanged, bolted bonnet, OS&Y, iron body, bronze trimmed, with body and bonnet
34 conforming to ASTM A126 Class B cast iron. Packing and gaskets to be non-asbestos.
35
36 Check Valves: Valves shall be swing-type manufactured in accordance with MSS SP-71, Class 125,
37 flanged ASTM A126 Class B cast iron body with bronze trim, non-asbestos gasket, or wafer-style with
38 stainless steel SP-ring, bronze disc plates, rubber seat, body of cast iron ASTM A126 Class B or A48 for use
39 with Class 125/150 flanges. SP-ring-actuated valve to be used on pump discharge.
40
41

42 **SPECIAL VALVES AND HYDRANTS**

43
44 Hose Bibbs: Bronze body, renewable composition disc, tee handle, 3/4" NPT inlet, 3/4" hose outlet.
45
46 Sill Faucets: Bronze body, with renewable composition disc, wheel handle, 3/4" solder inlet, 3/4" hose outlet.
47
48 Recessed Non-Freeze Wall Hydrants: Cast-bronze box, with chrome plated face, tee handle key, vacuum breaker,
49 hinged locking cover, 3/4" inlet, and hose outlet. Bronze casing shall be length to suit wall thickness and place the
50 shutoff control valve within the heated space.
51
52 Projecting Non-Freeze Wall Hydrants: Cast-bronze, with chrome plated face, tee handle key, vacuum breaker, 3/4"
53 inlet, and hose outlet. Bronze casing shall be length to suit wall thickness and place the shutoff control valve within
54 the heated space.
55
56 Floor Level Non-Freeze Hydrants: Cast-bronze hydrant, with rough bronze box, tee handle key, drain hole, vacuum
57 breaker, hinged locking cover, 3/4" inlet, and hose outlet. Bronze casing shall be length to suit depth of bury.
58
59 Non-Freeze Post Hydrants: Cast-bronze hydrant, with tee handle key, drain hole, vacuum breaker, 3/4" inlet, and
60 hose outlet. Bronze casing with cast-iron casing guard shall be length to suit depth of bury.
61
62

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".

Pressure Regulating Valves: Single seated, direct acting type, having dezincification 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 type water hammer arresters, stainless steel casing and bellows, pressure rated for 250 psi, tested and certified in accordance with PDI Standard WH-201.

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, phosphor 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*.

Press copper fittings shall be installed as follows:

Install press fittings in strict accordance with the manufacturer's instructions.

Before installation, inspect each fitting to ensure O-rings and stainless steel grip rings, as applicable, are in place and free from damage.

Copper tubing shall be cut square with a wheeled copper tubing cutter or equivalent cutting tool. Take care to not deform tube ends.

Tubing shall be wiped clean and any burrs are reamed with a deburring or reaming tool.

Insert tubing into the fitting and each joint pressed using a tool approved by the manufacturer.

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 220517 at 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*.

Press copper fittings shall be installed as follows:

Install press fittings in strict accordance with the manufacturer's instructions.

Before installation, inspect each fitting to ensure O-rings and stainless steel grip rings, as

applicable, are in place and free from damage.

Copper tubing shall be cut square with a wheeled copper tubing cutter or equivalent cutting tool. Take care to not deform tube ends.

Tubing shall be wiped clean and any burrs are reamed with a deburring or reaming tool.

Insert tubing into the fitting and each joint pressed using a tool approved by the manufacturer.

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.

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.

1 **FIELD QUALITY CONTROL**

2
3 Inspection:

4
5 Do not enclose, cover, or put into operation water distribution piping system until it has been inspected and
6 approved by the authority having jurisdiction.

7
8 Notify the authority having jurisdiction at least 24 hours prior to the time such inspection must be made.
9 Perform tests specified below in the presence of the authority.

10
11 Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed-in
12 after system is roughed-in, and prior to setting fixtures.

13
14 Final Inspection: Arrange for a final inspection by the authority having jurisdiction to observe the
15 tests specified below and to insure compliance with the requirements of the plumbing code.

16
17 Whenever the authority having jurisdiction finds that the piping system will not pass the test or inspection,
18 make the required corrections and arrange for reinspection by the plumbing official.

19
20 Piping System Tests:

21
22 Conduct hydrostatic and leakage tests of water systems in accordance with Article 312 of the *North Carolina*
23 *State Building Code: Plumbing Code*. Test for leaks and defects all new water distribution piping systems
24 and parts of existing systems, which have been altered, extended or repaired. If testing is performed in
25 segments, submit a separate report for each test, complete with a diagram of the portion of the system
26 tested.

27
28 Leave uncovered and unconcealed all new, altered, extended, or replaced water distribution piping until it
29 has been tested and approved. Expose all such work for testing, that has been covered or concealed before
30 it has been tested and approved.

31
32 Cap and subject the piping system to a static water pressure of 50 psig above the operating pressure or 100
33 psig whichever is greater without exceeding the pressure rating of the piping system materials. Isolate the
34 test source and allow to stand for a period of 4 hours. Leaks and loss in test pressure constitute defects that
35 must be repaired.

36
37 Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory
38 results are obtained.
39 Prepare reports for all tests and required corrective action.

40
41
42 **ADJUSTING AND CLEANING**

43
44 Purge all new potable water piping systems and parts of existing systems that have been altered, extended, or
45 repaired prior to use.

46
47 Use the purging and disinfecting procedure prescribed by the authority having jurisdiction, or in case a method is not
48 prescribed by that authority, the procedure described in either AWWA C601 or AWWA D105, or as described below:

49
50 Flush the piping system with clean, potable water until dirty water does not appear at the points of outlet for
51 at least 10 minutes. Flush with water flowing at design flow rate. During flushing, protect fixtures with
52 aerators as follows:

53
54 Remove aerators before flushing. After flushing, clean aerators by rinsing with clean water before
55 replacement.

56
57 Fill the system or part thereof, with a water/chlorine solution containing at least 50 parts per million of
58 available chlorine. Chlorinating agent shall be as selected by the Contractor and reviewed by the A/E.
59 Acceptable chlorinating agents are calcium hypochlorite and sodium hypochlorite

60
61 Do not place chlorine tablets or powder in the piping. Placing chlorine tablets or powder in
62 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 221116 - FACILITY WATER DISTRIBUTION PIPING

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 water-distribution piping and related components outside the building for water service and fire-service mains.

1.3 DEFINITIONS

- A. PVC: Polyvinyl chloride plastic.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.
 - 1. Wiring Diagrams: Power, signal, and control wiring for alarms.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: For piping and specialties including relation to other services in same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.
- B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For water valves and specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Regulatory Requirements:

1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
 2. Comply with standards of authorities having jurisdiction for potable-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.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. 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.
- B. 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.
- C. 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.
- D. 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.
- E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
- F. Protect flanges, fittings, and specialties from moisture and dirt.
- G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.9 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 Architect, 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 Owner's written permission.

1.10 COORDINATION

- A. Coordinate connection to water main with utility company.

PART 2 - PRODUCTS

2.1 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.
 - 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.
- B. 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.
- C. Flanges: ASME 16.1, Class 125, cast iron.

2.2 PVC PIPE AND FITTINGS

- A. PVC, Schedule 40 Pipe: ASTM D1785.
 - 1. PVC, Schedule 40 Socket Fittings: ASTM D2466.
- B. PVC, Schedule 80 Pipe: ASTM D1785.
 - 1. PVC, Schedule 80 Socket Fittings: ASTM D2467.
 - 2. PVC, Schedule 80 Threaded Fittings: ASTM D2464.

- C. PVC, AWWA Pipe: AWWA C900, Class 150 and Class 200, with bell end with gasket, and with spigot end.
 - 1. Comply with UL 1285 for fire-service mains if indicated.
 - 2. PVC Fabricated Fittings: AWWA C900, Class 150 and Class 200, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
 - 3. PVC Molded Fittings: AWWA C907, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
 - 4. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - a. Gaskets: AWWA C111, rubber.
 - 5. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.3 GATE VALVES

- A. AWWA, Cast-Iron Gate Valves:
 - 1. Non-rising-Stem, Metal-Seated Gate Valves:
 - a. Description: Gray- or ductile-iron body and bonnet; with cast-iron or bronze double-disc gate, bronze gate rings, bronze stem, and stem nut.
 - 1) Standard: AWWA C500.
 - 2) Minimum Pressure Rating: 200 psig.
 - 3) End Connections: Mechanical joint.
 - 4) Interior Coating: Complying with AWWA C550.
 - 2. Non-rising-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.
 - 1) Standard: AWWA C509.
 - 2) Minimum Pressure Rating: 200 psig.
 - 3) End Connections: Mechanical joint.
 - 4) Interior Coating: Complying with AWWA C550.

2.4 GATE VALVE ACCESSORIES AND SPECIALTIES

- A. Tapping-Sleeve Assemblies:
 - 1. Description: Sleeve and valve compatible with drilling machine.

- a. Standard: MSS SP-60.
 - 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, non-rising-stem, metal or resilient-seated gate valve with one raised face flange mating tapping-sleeve flange.
- B. Valve Boxes: Comply with AWWA M44 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.
- 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.

2.5 FIRE HYDRANTS

- A. All hydrants shall be of the City of Durham established standards.
- B. Dry-Barrel Fire Hydrants:
- 1. Description: Freestanding, with one NPS 4-1/2 and two NPS 2-1/2 outlets, 5-1/4-inch main valve, drain valve, and NPS 6 mechanical-joint inlet. Include interior coating according to AWWA C550. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure.
 - a. Standard: AWWA C502.
 - b. Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
 - c. Operating and Cap Nuts: Pentagon, 1-1/2 inches point to flat.
 - d. Direction of Opening: Open hydrant valve by turning operating nut to left or counterclockwise.
 - e. Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.

2.6 FIRE DEPARTMENT CONNECTIONS

- A. Fire Department Connections:
- 1. Description: Freestanding, with cast-bronze body, thread inlets according to NFPA 1963 and matching local fire department hose threads, and threaded bottom outlet. Include lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch-high brass sleeve; and round escutcheon plate.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Refer to Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 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.
- E. Underground water-service piping NPS 4 to NPS 8 shall be any of the following:
 - 1. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed or mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical joints.
- F. Underground Fire-Service-Main Piping NPS 4 to NPS 12 shall be any of the following:
 - 1. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed or mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical joints.

3.3 VALVE APPLICATIONS

- A. General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults.
- 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, non-rising-stem, metal or resilient-seated gate valves with valve box.

3.4 PIPING INSTALLATION

- A. Water-Main Connection: Tap water main according to requirements of water utility company and of size and in location indicated.
- B. 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.
- C. Comply with NFPA 24 for fire-service-main piping materials and installation.
- D. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.
- E. Bury piping with a minimum depth of cover over top at least 36 inches.
- F. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.
- G. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.
1. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.
- H. 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.

3.5 JOINT CONSTRUCTION

- A. See Section 330500 "Common Work Results for Utilities" for basic piping joint construction.
- B. 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. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.

3.6 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.

- 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.

3.7 VALVE INSTALLATION

- A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.
- B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.

3.8 FIRE HYDRANT INSTALLATION

- A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.
- B. AWWA Fire Hydrants: Comply with AWWA M17.

3.9 FIRE DEPARTMENT CONNECTION INSTALLATION

- A. Install ball drip valves at each check valve for fire department connection to mains.
- B. Install protective pipe bollards as indicated in the drawings around each of the fire department connection. Pipe bollards are specified in Section 055000 "Metal Fabrications."

3.10 ALARM DEVICE INSTALLATION

- A. General: Comply with NFPA 24 for devices and methods of valve supervision. Underground valves with valve box do not require supervision.
- B. 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.
- C. 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.

- D. Connect alarm devices to building fire alarm system.

3.11 CONNECTIONS

- A. Connect water-distribution piping to existing water main. Use tapping sleeve and tapping valve unless otherwise identified in the drawings.
- B. Connect water-distribution piping to interior domestic water and fire-suppression piping.

3.12 FIELD QUALITY CONTROL

- A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
- B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.
 - 1. 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.
- C. Prepare reports of testing activities.

3.13 IDENTIFICATION

- A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section 312000 "Earth Moving."

3.14 CLEANING

- A. Clean and disinfect water-distribution piping as follows:
 - 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. 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.

END OF SECTION 221116

SECTION 221313 - FACILITY SANITARY SEWERS

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. Ductile-iron, gravity sewer pipe and fittings.
2. PVC pipe and fittings.
3. Backwater valves.
4. Cleanouts.
5. Manholes.
6. Concrete.

1.3 ACTION SUBMITTALS

- A. Product Data: For the following:

1. Pipe and fittings.
2. Backwater valves.
3. Cleanouts.

- B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of pipe and fitting.
- B. Field quality-control reports.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, 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.

1.6 FIELD 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 Architect, 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 Owner's written permission.

PART 2 - PRODUCTS

2.1 DUCTILE-IRON, GRAVITY SEWER PIPE AND FITTINGS

- A. Pipe: ASTM A 746, for push-on joints.
- B. Standard Fittings: AWWA C110/A21.10, ductile or gray iron, for push-on joints.
- C. Compact Fittings: AWWA C153/A21.53, ductile iron, for push-on joints.
- D. Gaskets: AWWA C111/A21.11, rubber.

2.2 PVC PIPE AND FITTINGS

- A. PVC Gravity Sewer Piping:
 - 1. Pipe and Fittings: ASTM F 679, T-1 wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F 477, elastomeric seals for gasketed joints.

2.3 CLEANOUTS

- A. Cast-Iron Cleanouts:
 - 1. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
 - 2. Top-Loading Classification(s): Heavy Duty.
 - 3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

2.4 MANHOLES

- A. 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 4-inch minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
5. Riser Sections: 4-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.
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 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
10. 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.
11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Designed Precast Concrete Manholes:

1. Description: ASTM C 913; designed according to ASTM C 890 for A-16 (ASSHTO HS20-44 in AASHTO HL), 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 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
6. 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.
7. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

C. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser, with 4-inch-minimum-width flange and 26-inch-diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."

2.5 CONCRETE

- A. General: Cast-in-place concrete complying with ACI 318, ACI 350, and the following:
 1. Cement: ASTM C 150/C 150M, Type II.
 2. Fine Aggregate: ASTM C 33/C 33M, sand.
 3. Coarse Aggregate: ASTM C 33/C 33M, crushed gravel.
 4. Water: Potable.
- B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.
 1. Reinforcing Fabric: ASTM A 1064/A 1064M, steel, welded wire fabric, plain.
 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel.
- C. 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: 4 percent.
- D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
 1. Reinforcing Fabric: ASTM A1064/A 1064M, steel, welded wire fabric, plain.
 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details to 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.
- B. 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.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- D. 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.
- E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
- F. Install gravity-flow, non-pressure, drainage piping according to the following:
 - 1. Install piping pitched down in direction of flow, at minimum slope of 1 percent unless otherwise indicated.
 - 2. Install piping with 36-inch minimum cover.
 - 3. Install ductile-iron, gravity sewer piping according to ASTM A 746.
 - 4. Install PVC gravity sewer piping according to ASTM D 2321 and ASTM F 1668.
- G. 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.

3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, non-pressure, drainage piping according to the following:
 - 1. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.
 - 2. Join PVC gravity sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.

3.4 MANHOLE INSTALLATION

- A. General: Install manholes complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C 891.
- C. Form continuous concrete channels and benches between inlets and outlet.

- D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

3.5 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318.

3.6 BACKWATER VALVE INSTALLATION

- A. Install horizontal-type backwater valves in piping manholes or pits.
- B. Install combination horizontal and manual gate-type valves in piping and in manholes.
- C. Install terminal-type backwater valves on end of piping and in manholes. Secure units to sidewalls.

3.7 CLEANOUT INSTALLATION

- A. 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 Heavy-Duty, top-loading classification cleanouts in all areas.
- B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.
- C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.8 CONNECTIONS

- A. Connect non-pressure, gravity-flow drainage piping to building's sanitary building drains specified in Section 221316 "Sanitary Waste and Vent Piping."
- B. 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. 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.

3.9 CLOSING ABANDONED SANITARY SEWER SYSTEMS

- A. 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:
 - 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.
- B. 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 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.
- C. Backfill to grade according to Section 312000 "Earth Moving."

3.10 IDENTIFICATION

- A. Comply with requirements in Section 312000 "Earth Moving" for underground utility identification devices. Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.
 - 1. Use warning tape or detectable warning tape over ferrous piping.
 - 2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.11 FIELD QUALITY CONTROL

- A. 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. Re-inspect and repeat procedure until results are satisfactory.
- B. 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.
 5. 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.
 6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Test plastic gravity sewer piping according to ASTM F 1417.
 - b. Test concrete gravity sewer piping according to ASTM C 1628.
 7. Manholes: Perform hydraulic test according to ASTM C 969.
- C. Leaks and loss in test pressure constitute defects that must be repaired.
- D. Replace leaking piping using new materials and repeat testing until leakage is within allowances specified.

3.12 CLEANING

- A. Clean dirt and superfluous material from interior of piping. Flush with potable water.

END OF SECTION 221313

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 and, as applicable, gray water recycling 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 will be provided under Division 7. 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.

Training Tower Piping for Smoke System:

Polyvinyl Chloride (PVC) Drainage, Waste, and Vent (DWV) 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 2565 joints.

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 check 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 1/2" 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.

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

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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.

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 indicated 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.

- 1 Integral, Atmospheric Vacuum Breakers: ASSE 1001.
2
3 Sensor-Actuated Faucets and Electrical Devices: UL 1951.
4
5 Comply with the following applicable standards and other requirements specified for bathtub/shower faucets:
6
7 Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
8
9 Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
10
11 Deck-Mounted Bath/Shower Transfer Valves: ASME 18.7.
12
13 Hand-Held Showers: ASSE 1014.
14
15 High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
16
17 Manual-Control Antiscald Faucets: ASTM F 444.
18
19 Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
20
21 Sensor-Actuated Faucets and Electrical Devices: UL 1951.
22
23 Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
24
25 Comply with the following applicable standards and other requirements specified for the following plumbing fixture
26 elements:
27
28 Atmospheric Vacuum Breakers: ASSE 1001.
29
30 Brass and Copper Supplies: ASME A112.18.1.
31
32 Flexible Water Connectors: ASME A112.18.6.
33
34 Floor Drains: ASME A112.6.3.
35
36 Flushometers, Manual-Operation : ASSE 1037.
37
38 Flushometers, Sensor-Operation: ASSE 1037 and UL 1951.
39
40 Grab Bars: ASTM F 446.
41
42 Hose-Coupling Threads: ASME B1.20.7.
43
44 Hot-Water Dispensers: ASSE 1023 and UL 499.
45
46 Off-Floor Fixture Supports: ASME A112.6.1M.
47
48 Plastic Shower Receptors: ANSI Z124.2.
49
50 Plastic Toilet Seats: ANSI Z124.5.
51
52 Supply and Drain Protective Shielding Guards: ICC A117.1.
53
54

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 or 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.

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.

Thermostatic Mixing Valves: Leonard; Powers; or Armstrong.

Shower Valves: Symmons; Leonard Valve Co; Powers; or Lawler.

- 1 Sink and Lavatory Faucets: Zurn Commercial; Moen Commercial; Chicago Faucets; Delta Commercial (Tek
2 Institutional); Sloan Valve Co.; Symmons Industries, Inc.; or T&S Brass and Bronze works, Inc.
3
4 Flush Valves: Sloan Valve Co.; Delta Commercial (Tek Institutional); Toto USA; Delany Products or Zurn
5 Industries, Inc.
6
7 Fixture Carriers: Josam Mfg. Co.; Wade Division/Tyler Pipe; Zurn Industries, Inc., Hydromechanics Div.; or
8 Jay R. Smith Mfg. Co.
9
10 Emergency Care Fixtures and Equipment: Haws Mfg. Co.; Guardian Equipment; Western Safety Equipment
11 Co.; WaterSaver or Bradley Corporation.
12
13 Floor Drains and Sinks: Josam Mfg. Co.; Zurn Industries, Inc., Hydromechanics Div.; Jay R. Smith Mfg. Co.;
14 Wade; Watts Regulator Co.; or Mifab, Inc.
15
16 Mop Service Basins: Fiat Products; E.L. Mustee & Sons, Inc.; Florestone Inc.
17
18 Materials:
19
20 Provide materials which have been selected for their surface flatness and smoothness. Exposed surfaces
21 which exhibit pitting seam marks, roller marks, foundry sand holes, stains, discoloration, or other surface
22 imperfections on finished units are not acceptable.
23
24 Where fittings, trim and accessories are exposed or semi-exposed provide bright chrome-plated or polished
25 stainless steel units. Provide copper or brass where not exposed.
26
27 Stainless Steel Sheets: ASTM A167, Type 302/304, hardest workable temper with No. 4, bright finish,
28 directionally polished on exposed surfaces.
29
30 Steel Sheets for Baked Enamel Finish: ASTM A 591, coating Class C, galvanized-bonderized.
31
32 Steel Sheets for Porcelain Enamel Finish: ASTM A 424, commercial quality, Type 1.
33
34 Galvanized Steel Sheet: ASTM A 526, except ASTM A 527 for extensive forming; ASTM A 525, G90 zinc
35 coating, chemical treatment.
36
37 Aluminum: ASTM B 209/B 221 sheet, plate, and extrusions, as indicated; alloy, temper and finish as
38 determined by manufacturer, except 0.40 mil natural anodized finish on exposed work unless another finish
39 is indicated.
40
41 Vitreous China: High quality, free from fire cracks, spots, blisters, pinholes and specks; glaze exposed
42 surfaces, and test for crazing resistance in accordance with ASTM C554.
43
44 Shower Valves and Faucets:
45
46 Heavy duty cast brass or machined brass construction, pressure balancing, unless otherwise specified, with
47 integral check stops and chrome plated brass face plate or escutcheon. Refer to plans for accessories.
48
49
50

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: 1/2" 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:

Sensor-Operated Faucets: Actuation of faucet shall be via solenoid controlled by hardwired, dual beam infrared or multi-spectrum electronic sensor; adjustable cycles. ASSE 1070 compliant.

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, 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 1.1 gal/flush

Liquids and Solids Flush (handle down): Maximum 1.6 gal/flush

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:

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 1/4" x 1 1/2" 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 1/2" brass tailpiece assembly, Elkay LK35, with 1 1/2" x 1 1/2" 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 1/4" 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 1/4" 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 1/4" 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.

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

1 stream.

2
3 Replace washers of leaking or dripping faucets and stops.

4
5
6 **PROTECTION**

7
8 Protect installed fixtures from damage during remainder of construction period.

9
10 **Do not allow use of fixtures as temporary sanitary facilities during construction unless expressly approved**
11 **in writing by the Owner.**

12
13 Prior to final acceptance, clean fixtures, brass, trim, etc. using manufacturer's recommended cleaning methods and
14 materials.

15
16 **OWNER INSTRUCTION AND TRAINING**

17
18 Provide Owner instruction and training in accordance with Section 019926.

19
20 **END OF SECTION 224000**

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SECTION 230210 – HVAC SUMMARY OF WORK

Engineer of Record for Heating, Ventilating, and Air-Conditioning work is Kevin R. Allen, PE, Salas O'Brien, 702 Oberlin Road, Suite 300, Raleigh, NC 27605. 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 and 25 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.



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
230517	Sleeves and Sleeve Seals for HVAC Piping
230521	HVAC Piping Specialties
230529	Hangers and Supports for Piping, Ductwork & Equipment
230548	HVAC Vibration Control
230553	HVAC Painting and Identification
	Appendix - Mechanical and Plumbing Identification
230593	HVAC Testing, Adjusting, and Balancing
230596	HVAC Systems Commissioning
230719	HVAC Piping Insulation
230913	Instrumentation and Control Devices for HVAC
230923	Direct Digital Control System for HVAC
	Appendix A
233100	HVAC Ductwork
233300	Air Duct Accessories
233423	HVAC Power Ventilators
233713	Diffusers, Registers, and Grilles
235543	Unfired Unit Heaters
238116	Ductless Split System Air-Conditioning Units

DIVISION 25 – INTEGRATED AUTOMATION

Section	Title
251510	Energy Management Information Systems
	Appendix A – Skyspark Rules

END OF SECTION 230210

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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.

EQUIPMENT SELECTION

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, duct routing, etc. that will increase the fan static pressures, any 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	80 deg F	Floating
	Relative Humidity	Floating	Floating

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

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.

1 During temporary operation of air systems, the following additional measures are required:

2
3 Install temporary roll media filters (minimum MERV 13) over each air inlet (return or exhaust). Temporary
4 filters shall be replaced regularly in order to minimize pressure losses impose on fans.

5
6 Windings of open, drip proof electric motors shall be cleaned using low pressure compressed air at the end
7 of each 72 hours of operation.

8
9 Once HVAC systems verification/commissioning has been completed, air systems shall be shut down, temporary
10 filters removed, and air handler filters replaced with new unless specifically directed otherwise by the A-E. **Only**
11 **upon receipt of written approval by the A-E shall HVAC systems be placed into final service prior to**
12 **Substantial Completion of the Project.**

13
14
15 **END OF SECTION 230510**

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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

1 Disconnect switches shall be sized for all other applications based on total kW rating of the equipment as
2 follows:
3

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

4
5 Dual element fuses shall be provided with disconnect switches. Fuses shall be sized based on the
6 nameplate rating for the equipment.
7

8 Equipment enclosures for disconnect switches, starters, variable frequency drives, control panels and any
9 other panel enclosures housing electrical equipment shall be rated based on NEMA standard ratings. Panel
10 enclosures shall be suitable for the environment in which they will be installed. Unless noted otherwise,
11 provide NEMA rated enclosures based on the following environment conditions:
12

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

13
14 Provide all single phase interlock and control wiring required for sequenced operation of mechanical devices
15 provided for mechanical systems under Division 23. Under Divisions 26-28, a source of power for these
16 devices shall be provided and extended to the devices under Division 23.
17

18 Make all power wiring connections for mechanical equipment as recommended by the equipment
19 manufacturer. Under Divisions 26-28, power wiring to the line side of a disconnecting provided and installed
20 under Division 23 will be provided.
21

22 Some items of equipment may require conductor and/or raceway combinations different from the
23 supply conductors provided under Division 26-29 to the equipment disconnect; coordinate and
24 provide connections as recommended by the equipment manufacturer.
25

26 Division 23 Contractor is responsible for providing and installing fuses in disconnects that supply Division 23
27 utilization equipment.
28

29 Provide any required power wiring not specifically shown on the electrical drawings (E-Sheets) or specified
30 in Divisions 26-28.
31

32 Install duct smoke detectors furnished under Divisions 26-28 and incorporate smoke detectors in interlock
33 and control wiring. Provide appropriate access doors for duct smoke detectors.
34
35
36

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, Subpart 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.

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 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
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.

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.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 230521

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 Gas Refrigerant Piping
Type 3: Cold Systems	Type 3A: 32-70	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 Type 1A piping 2" NPS and smaller.

Copper Pipe Hangers: Copper-plated or -coated steel.

Insulation Protection: Provide MSS Type 40 insulation shield for Classification Types 1A 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.

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.

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.

EQUIPMENT HANGERS AND SUPPORTS

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.

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 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.**

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.**

INSTALLATION OF EQUIPMENT HANGERS AND SUPPORTS

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 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.

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.

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.

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

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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

WTCC has existing labeling and color schedule in their guidelines which are to be used on this project. See Appendix "A". The Contractor shall use these labeling guidelines for equipment, ductwork, valves, and piping. The contractor shall use the below requirements only where there are no similar requirements in the WTCC guidelines.

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.

a. Equipment Identification

- All major HVAC equipment shall be properly identified with equipment identification, equipment controlled, electrical ratings and date of installation.
- Equipment shall be clearly identified with engraved phenolic nameplates securely fastened to the equipment with sheet metal screws. Nameplates shall have white background and black lettering.
- Nameplates shall be a minimum 4" by 2" size with 1/2" minimum lettering. Equipment name/numbers shall be the same as shown in the contract documents and the BAS Control drawings. Nameplates smaller than 4" by 2" shall only be allowed with approval from the designer.

- For serviceable equipment located above an acoustical lay-in ceiling, provide a clear adhesive label on the ceiling grid directly below the equipment. For equipment located above a drywall or hard ceiling, provide the label on an adjacent vertical surface (location approved by the designer) or on the ceiling access panel for that piece of equipment. The label shall indicate the equipment designation in black text with minimum 3/8" high lettering.

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.

PART 3 - EXECUTION

WTCC has existing labeling and color schedule in their guidelines which are to be used on this project. The Contractor shall obtain a copy of the guidelines and comply with the utilize these labeling guidelines for equipment, ductwork, valves, and piping. The contractor shall use the below requirements only where there are no similar requirements in the WTCC guidelines.

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.

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.

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:

Fans and primary balancing dampers

DUCTWORK IDENTIFICATION

Label ductwork exposed to view in mechanical equipment rooms 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.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 230553

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APPENDIX A

FIRE PROTECTION, PLUMBING AND MECHANICAL SYSTEMS DESIGN GUIDELINES

Note that sections highlighted in yellow indicate changes from the previous edition of this guideline.

Identification

a. Equipment Identification

- Specify that all major **fire protection**, HVAC and plumbing equipment, **including but not limited to air handlers, fans, pumps, etc.** is properly identified with equipment identification, equipment controlled, electrical ratings and date of installation.
- Equipment should be clearly identified with engraved phenolic nameplates securely fastened to the equipment with sheet metal screws. Specify nameplates with white background and black lettering.
- Nameplates shall be a minimum 4" by 2" size with ½" minimum lettering. Equipment name/numbers shall be the same as shown in the contract documents and the BAS Control drawings. Nameplates smaller than 4" by 2" shall only be allowed with approval from the designer.
- For serviceable equipment such as VAV Boxes, AHU's, reheat coils, exhaust fans, pumps, etc. located above an acoustical lay-in ceiling, provide a clear adhesive label on the ceiling grid directly below the equipment. For equipment located above a drywall or hard ceiling, provide the label on an adjacent vertical surface (location approved by the designer) or on the ceiling access panel for that piece of equipment. The label shall indicate the equipment designation in black text with minimum 3/8" high lettering.
- For miscellaneous equipment requiring access such as valves, control dampers, access doors, etc., provide a ¾" colored adhesive button on the ceiling grid directly below the equipment. For equipment located above a drywall or hard ceiling, provide the label on an adjacent vertical surface (location approved by the designer) or on the access panel for that piece of equipment. Button colors shall be as follows; Plumbing-Green, HVAC-Blue, Fire Sprinkler-Red.

b. Pipe and Duct Identification

- Completely paint piping systems in mechanical rooms with the applicable colors listed below.
- For both piping and ducts, provide stencil or strap-on identification indicating the system and the direction of flow.
- Identification shall be provided as follows: no further than 30 feet apart, at major changes in direction, at each valve or equipment, and on both sides of penetrations.
- The system colors and identifications are as follows:

<u>Pipe/Duct System</u>	<u>Pipe/Duct Color</u>	<u>Stencil Identification</u>	<u>Label Color</u>	<u>Lettering Color</u>
Condensate Return	Black	COND	Green	White
Chilled Water Supply	Dark Blue	CHWS	Green	White
Chilled Water Return	Dark Blue	CHWR	Green	White
Domestic Cold Water	Dark Green	DOM CW	Green	White

Lab Cold Water	Light Blue	LAB CW	Light Blue	White
Deionized Water	Slate Gray	DSTW	Green	White
Condenser Water Supply	Dark Gray	CWS	Green	White
Condenser Water Return	Dark Gray	CWR	Green	White
Domestic Hot Water	Light Orange	DHW	Green	White
Lab Hot Water	Dark Yellow	LAB HW	Dark Yellow	Black
Domestic HW Recirculating	Light Orange	DHWR	Green	White
Lab Hot Water Recirculating	Dark Yellow	LAB HWR	Dark Yellow	Black
Geothermal Water Supply	Dark Gray	GWS	Green	White
Geothermal Water Return	Dark Gray	GWR	Green	White
Reclaim Water	Purple	RECLAIM	Yellow	Black
Storm Drainage	Same as surrounding area***	STORM	Green	White
Sanitary Drainage & Vent	Same as surrounding area***			
Refrigerant	Black	REFRIG	Yellow	Black
Heating Water Supply	Dark Orange	HHWS	Green	White
Heating Water Return	Dark Orange	HHWR	Green	White
Natural Gas	Yellow	GAS	Yellow	Black
Air	Dark Gray	AIR	Green	White
Nitrogen	Pastel Gray	NITROGEN	Green	White
Helium	Pastel Gray	HELIUM	Green	White
Hydrogen	Black	HYDROGEN	Green	White
Vacuum	Beige	VAC	Green	White
Compressed Air	Gray	CA	Blue	White

Argon	Blue	ARGON	White	Black
Argon/CO2	Red	ARGON/CO2	White	Black
Controls Conduit	Yellow**			
Sprinkler	Safety Red	SPKR	Safety Red	White
Fire Line	Safety Red	FIRE	Safety Red	White
Supply Ductwork	White*	SUPPLY AIR	Green	White
Return Ductwork	White*	RETURN AIR	Green	White
Relief Ductwork	White*	RELIEF AIR	Blue	White
Outside Air Ductwork	White*	OUTSIDE AIR	Blue	White
Exhaust Ductwork	Same as surrounding area***	EXHAUST	Yellow	Black

- *White jacketing applies to insulated, non-concealed ductwork.
- ** Controls conduit shall be specified as factory painted.
- *** Piping or ductwork shall be unpainted unless the surrounding area is to be completely painted, then paint the piping same color as the surrounding area.
- Pipe identification should contrast in color to the pipe colors and be easily readable. The width of color bands should be equal to the size of the stencil indicated below.
- For insulated and un-insulated pipe systems, stencil sizes are as follows:
 - For pipes up to 1 inch, use 1/2 inch letters, 8" wide color band.
 - For pipes >1 inch to 2 inches, use 3/4 inch letters, 8" wide color band.
 - For pipes >2 inches to 4 inches, use 1 1/4 inch letters, 12" wide color band.
 - For pipes >4 inches to 6 inches, use 1 1/4 inch letters, 12" wide color band.
 - For pipes above 6 inches, use 4 inch letters, 24" wide color band.
- At each floor level and at roof level identify each exhaust air duct from safety cabinets and fume hoods by 2" tall painted black lettering identifying the room it originates from.

c. Valve Identification

- Specify brass valve tags, minimum 1.5" diameter, minimum 1/4" high lettering for the service matching the chart in paragraph b. above, minimum 1/2" high lettering indicating valve number, with brass or stainless steel chains for all isolation, branch and control valves.
- Specify a valve tag chart to be included in the O&M manual.
- Specify a valve tag chart to be mounted in all ME rooms in a frame with lexan cover.
- Include the tag numbers in the as-built drawings and record drawings.

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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 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).

Verification of HVAC systems requires participation by the TAB subcontractor as a member of the "Verification Team". See Section 230596 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 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

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 exhaust airflows.

Location and position of balancing devices

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:

Fans

Identification	Total airflow rate in cfm
Location	Total system static pressure in inches wg
Fan type	Fan rpm
Manufacturer	Discharge static pressure in inches wg
Manufacturer model number and size	Suction static pressure in inches wg
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
Unit Heaters	
Identification Location Room or area served Manufacturer Manufacturer model number and serial number Fan motor horsepower and rpm Fan motor FLA and service facto	Electric Unit Heater: Heat output in kW Coil voltage at each connection. Coil amps for each phase. Fan: Air flow rate in cfm Air velocity in fpm Entering-air temperature in deg F Leaving-air temperature in deg F Motor voltage Motor amps

TEST AND BALANCE PROCEDURES

Test Instruments Calibration: Instruments for air 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.**

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 systems as follows:

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 systems balance.

During the A/E check, the TAB contractor shall verify the full range of air 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 systems balance.

END OF SECTION 230593

SECTION 230596 – HVAC 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

HVAC systems commissioning shall be performed by the Contractor and shall include the following:

Establish a commissioning "team" consisting of the installing personnel, the controls subcontractor, and the testing, adjusting, and balancing (TAB) subcontractor(s).

Systematically evaluate all installed HVAC 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 HVAC 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 HVAC components, equipment, subsystems, and systems, along with the control requirements for each element. It is the intent of the Designer that all HVAC components, equipment, subsystems, and systems shall perform in accordance with the stipulated requirements through the entire operational range of each element, while satisfying temperature, humidity, air quality, acoustic, and vibration criteria defined in Section 230510.

SEQUENCES OF OPERATION

Sequences of operation shall be as indicated on Drawings.

PART 3 – FUNCTIONAL PERFORMANCE

SYSTEMS START-UP

Appendix 230596 outlines basic start up and check out requirements for HVAC systems and equipment. 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 230596 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 230596, 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 commissioning 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:

Mechanical Contractor's Representative
Testing, Adjusting and Balancing Representative
Controls Sub-Contractor Representative

_____"

END OF SECTION 230596

APPENDIX 230596 – HVAC SYSTEMS COMMISSIONING CHECKLISTS

Section	Component
232300	REFRIGERANT PIPING SYSTEMS

START-UP CHECKS

Confirm that piping is adequately supported and vibration isolation is addressed in accordance with Sections 230529 and 230548.

Confirm that piping has been painted and that piping and valves have been labeled in accordance with Section 230553.

Confirm that refrigerant piping is complete in accordance with Section 238116 and drawings. Confirm that system has been evacuated, charged, and pressure tested. Provide leak test report.

Make sure that refrigerant lines are insulated in accordance with Section 230719 and supported in accordance with Section 230529 and 230548.

Confirm that service valves are accessible.

FUNCTIONAL PERFORMANCE TESTS

Confirm that refrigerant pressures and temperatures comply with associated equipment requirements.

Section	Component
233423	FANS

START-UP CHECKS

Confirm that casing condition is good: no dents, leaks, door gaskets installed.

Confirm that vibration isolation has been installed.

Confirm that equipment guards and screens have been installed (as applicable).

Make sure that all plenums clear of debris

Confirm that fan rotates freely.

Confirm that fire dampers, backdraft dampers, and/or balancing dampers are installed and operate freely.

Confirm that electrical connections are complete.

Confirm that motor overload protection in place and properly sized.

START-UP PROCEDURES

Remove fan lockouts and start fan.

Confirm that fan fan rotation is correct.

Confirm that all fan interlocks work correctly.

FUNCTIONAL PERFORMANCE TESTS

Measure the airflow (CFM), static pressure (in. WG), and motor data (actual amps and volts, each phase) and compare to design and TAB data.

Test disconnect switch for proper operation

Section	Component
238116	DUCTLESS SPLIT SYSTEMS

**START-UP CHECKS, START-UP PROCEDURES, AND
FUNCTIONAL PERFORMANCE TESTS**

Confirm that units are installed in accordance with specifications and design drawings.

Ensure condensate drains properly and that trap is adequate.

Turn unit control to system-on position. Unit fan should be on.

Turn unit control to cooling position or set unit thermostat 10°F below space temperature.

Measure unit discharge air after unit is in cooling position for at least 5 minutes. This air should be below 60°F. The cooling coil should show condensation if the space dew point is over 50°F.

Turn unit control to heating position or set unit thermostat 10°F above space temperature. If hydronic heating system is used for the system, make sure the specified hot water temperature is available.

Measure unit airflow and compare to design and TAB data.

Measure motor current and compare to motor nameplate data.

END APPENDIX 230596

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

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.

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 3: Cold Systems	Type 3A: 32-70
	Type 3B: <32

Classification Type 3A Piping: Insulate the following cold HVAC piping systems:

Cooling coil condensate drain piping.

Condensate drain piping within 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.

Refrigerant suction piping may be insulated with $\frac{3}{4}$ " thick flexible elastomeric insulation.

GENERAL INSTALLATION REQUIREMENTS

For Classification Type 3 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.

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.

Install insulation continuously through hangers and around anchor attachments:

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.

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.

INSULATION INSTALLATION AT PENETRATIONS

Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

Seal penetrations 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 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 Fittings and Elbows:

Fabricate mitered sections of pipe insulation as fitting covers.

On soldered, brazed, or butt welded 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.

1 Insulation Installation on Valves and Pipe Specialties:

2
3 Install preformed valve covers manufactured of same material as pipe insulation when available.
4 When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve
5 body. Arrange insulation to permit access to packing and to allow valve operation without disturbing
6 insulation.

7
8 Install insulation to flanges as specified for flange insulation application.

9
10 Secure insulation to valves and specialties and seal longitudinal seams and butt joints with manufacturer's
11 recommended adhesive to eliminate openings in insulation that allow passage of air to surface being
12 insulated.

13
14 Insulation installed outdoors shall be painted with two coats of UV-inhibiting coating recommended by the insulation
15 manufacturer.

16
17
18 **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
Water Flow	±5% of full scale	

Temperature Sensors:

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.

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.

Water Flow Meters:

General: Provide water flow meters of materials, capacities, and ranges indicated, designed and constructed for use in service indicated. Flow meters shall be clamp-on type, ultrasonic measurement, 120V 60 Hz power input, and BACnet/IP compatible.

Acceptable manufacturer and model for flow meter products are any of the following:

1. Onicon, F-4300 Clamp-On Ultrasonic Flow Meter
2. Proline Prosonic Flow P 500 Clamp-On Ultrasonic Flow Meter
3. Dynasonics TFX-5000 Clamp-On Ultrasonic Flow Meter

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.

Mount sensors rigidly and adequately for the environment within which the sensor operates.

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.

Pipe Flow Meters/Sensors:

Install flow meters according to manufacturer's written instructions.

Mount flow meter a minimum of 5 pipe diameters up stream and 10 pipe diameters downstream or 2 feet, whichever is greater, from fittings and other obstructions.

Assure correct flow direction and alignment.

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

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SECTION 230923 – DIRECT DIGITAL CONTROL SYSTEMS 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 251510 - Energy Mgt Info Systems

QUALITY ASSURANCE

The BAS is an open protocol BACnet communication DDC system. The BAS will be a stand-alone system capable of operating the building by itself. The college requires every building BAS to be connected to a common server known as the Energy Management Information System (EMIS). The EMIS is responsible for BAS front end functions such as building equipment and floor graphics, data fault detection and analytics, alarming, trending, scheduling, etc. The EMIS integration shall be performed by a Master System Integrator (MSI) during the project. The BAS contractor will coordinate with the MSI scope of work. Both contractors shall work together to for a complete installation, coordinating all logic division between the field devices and the Enterprise server.

Authorized Software Dealers: J2 Innovations FIN Framework, FIN Stack & nHAYSTACK.

Authorized Software Dealers: Essex Consulting Group, Inc., www.essexco.com, BC&S and CMS.

The below EMIS Software is existing and is stated for information only:

EMIS Server Software: Provide J2 Innovations FIN Stack software and database server

EMIS Server Software: Provide J2 Innovations nHaystack standard tagging and modeling server

EMIS Server Software: Provide J2 Innovations FIN Stack graphical system program development module

EMIS Server Software: Provide SkySpark software for Fault Detection and Analytics

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 controls system sub-contractor shall be responsible for the coordination and integration of all OEM supplied controls and include the OEM controls and sequences of operation into the submittal. 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.**

The EMIS at Wake Tech shall be developed by an MSI via open collaboration with the BAS contractor and functionally tested by the CX Agent. This coordinated work shall be completed prior to building Commissioning. BAS/MSI milestones shall be included in construction schedules and in OAC meetings. EMIS consistency shall be maintained with every project integration. The General Contractor or Mechanical Contractor shall contract both BAS and MSI companies. Wake Tech has developed a spreadsheet template that can help either GC or Mechanical Contractor to manage the coordination of this work. The BAS and MSI shall attend OAC meetings when required and/or requested to report on project progress and coordination between the MSI contractor and themselves.

The latest guidelines are found in Appendix A of this specification and are considered part of these contract documents. Where conflicts appear to exist between these documents, the contractor shall bring it to the attention of the engineer for resolution. The contractor shall bring to the attention of the college and the engineer, any discrepancies between this specification or other parts of these contract documents and the current BAS guidelines for resolution. Some, but not all of the BAS guidelines are incorporated into this specification. All requirements of the guidelines are to be followed regardless of whether they are repeated in this specification.

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.

BAS Engineer to be onsite with contractor when any host device is added to WTCC Network.
BAS Engineer to act as middleman between contractor and IT dept.

APPROVED FIELD EQUIPMENT CONTROL INSTALLERS

CMS Controls
Johnson Controls
Comfort Mechanical Contractors
EMCOR Services
Hoffman Building Technologies

APPROVED FIELD EQUIPMENT CONTROL MANUFACTURERS

Distech Controls
Facility Explorer (JCI)

Field equipment controllers (FEC) shall be BACnet IP compliant. Field controllers should have BACnet Testing Labs (BTL) certifications as B-AAC (BACnet Advanced Application Controller), B-ASC (BACnet Application Specific Controller), or B-BC (BACnet Building Controller) devices.

Supervisory control devices that require software licensing and ongoing service maintenance agreements are expressly prohibited (e.g. N4 JACEs). This prohibition also extends to BAS servers functioning as a building level supervisory controller that require ongoing software licensing or service maintenance agreements (SMAs).

In order to improve communication with enterprise software (BAS, analytics, dashboarding or other functions), the Contractor shall consider using middle-ware devices in buildings to communicate downstream to FECs via BACnet and upstream to enterprise software using other, presumably more efficient, communication protocols.

WORK EXECUTION – WARRANTY AND LICENSING

Licensing

All hardware, software and licensing of BAS and related components including analytics and dashboarding systems, shall be provided by Installer and up to date prior to the end of the project.

Warranty

The BAS shall be free from defects of material, and workmanship under normal use and service for a period of 12 months after final acceptance by the Owner. WTCC contracts one maintenance contracted service provider to have full responsibility for maintaining the BAS. If within the 12-month warranty period, any equipment, software, or labor is found to be defective in workmanship or materials, it shall be replaced by the BAS Controls installer at no cost to the owner. Warranty service calls shall be available to the job site during normal working hours.

Preventative Maintenance

- Manufacturer's Field Services: Provide the services of a factory-authorized service representative to start control systems. Shall be scheduled with owner.

- Test and adjust/calibrate controls and safeties.
- Replace damaged or malfunctioning controls and equipment.
- Start, test, and adjust control systems.
- Demonstrate compliance with requirements and provide results of pre-functional and functional field testing in a report.
- Adjust, calibrate, and fine tune circuits and equipment to achieve the sequence of operation specified without fault or failure.
- All tools, Testing and calibration equipment necessary to ensure reliability and accuracy of the controls system shall be supplied by controls contractor.

Codes Compliance

All work performed shall conform to City, County, State, and Federal regulations and codes in effect as of the date of Contract.

Permits

Except as otherwise indicated, the Controls Contractor shall secure and pay for all permits, inspections, and certifications required for work and arrange for all necessary approvals by the governing authorities.

National Codes and Standards

- a) NFPA 70 – National Electric Code (NEC)
 - b) ASHRAE - American Society of Heating, Refrigeration, and Air-Conditioning Engineers
 - c) ANSI/ASHRAE Standard 135 – BACnet: A Data Communication Protocol for Building Automation and Controls Networks.
 - d) UL 916 – Standard for Energy Management Equipment
 - e) Project Haystack. Project-haystack.org
 - f) FCC – Part 15, Subpart J
- City, County, State, and Federal regulations and codes in effect as of the date of Contract.

GUARANTEE PERIOD SERVICES

Maintenance of Control Hardware: The Contractor shall inspect, repair, replace, adjust, and calibrate, as required, 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 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 interface equipment, control units, communicating

thermostats, transducers/ transmitters, sensors, actuators, valves, relays/switches, control panels, operator interface equipment, etc.

Control Drawings: BAS Contractor submittal requirements

Title Page

IT Network/BACnet Network Layout

Network Schedule

- Information to include Controller Name, Location, Communication Protocol, MAC address, Controller Type, System, Description.

Communications Bus Layout

Equipment Drawings (The BAS contractor shall incorporate all OEM controllers, sequences of operations, and diagrams into their submittal).

- Sequence of Operations.
- Control Panel Layout- one for each Pane.
- Control Points List- one for each Device
- Complete Wiring and Schematic Diagrams.

**Terminal identification for all control wiring shall be shown on the Wiring and Schematic Diagrams.

**Submittal drawings shall also contain, software descriptions, calculations, and any other details required to demonstrate that the system has been coordinated and will properly function as a system.

DDC System Software:

Include technical data for operating system software, operator interface, color graphics, and other third-party applications.

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 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. Include network architecture drawing and location of network drop.

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: Certify that each proposed DDC system component complies with ASHRAE Standard 135-2012 **and is BACnet Laboratory tested and certified.**

Closeout Submittals:

Redlined as-built drawings for each equipment control panel shall be updated, printed in .pdf format, and installed in control panel for future WTCC troubleshooting. Redlines to include schematic, sequence, points list, wiring and schematic diagrams from submittals. Any corrections requested by WTCC shall be made and resubmitted.

Visio files used to create as built control drawings shall be submitted to WTCC.

The following shall be included in the close out documents:

- Typical literature included (if available - drawings do not need to be laminated)
- Systems Control Schematic(s)
- Controller Module I/O Layout(s)
- Systems Sequence of Operations
- Other pertinent information (Safety Circuit Wiring, Control Panel Layout(s))

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.

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: Provide electronic files.

Device address list. Include all BACnet address values and IP address/IT network information for all control data connections.

Printout of software application and graphic screens.

Software license required by and installed for DDC control systems or Package files required by DDC system.

Wake Tech Information Technology – IT

Overview

BAS systems must comply with WTCC's IT policies and work within the network infrastructure. As these policies and network architecture are subject to change,

1 Network Access

2
3 MSI and BAS Contractor's access with uncontrolled devices through VPN is not allowed on WTCC
4 network. Contractors must use WTCC Windows Virtual Desktop (WVD) procedures when outside
5 college network.

6
7 All Contractor personnel requiring network access shall coordinate with WTCC Project Manager.
8 Contractors will need to apply through HR to obtain a WTCC Key Account. Key Accounts will be
9 granted access to WVD and to work on specific BAS Servers. Access shall be maintained through the
10 Warranty period.

11 Private BAS Subnet

12 WTCC College IT Network is a segmented MAN (Metropolitan Area Network). Each building on
13 campus is separated into different broadcast areas by gateways.

- 14
 - BAS IP controllers shall use DHCP IPv4 settings. IT will lock IP address to DHCP server.
 - BAS network controllers shall use DHCP DNS settings.
 - Only one BACnet/IP Broadcast Management Device (BBMD) allowed per subnet.

17 Specific Field Equipment Controller Software

18 WTCC requires all specific field equipment controller software to be loaded and licensed onto a WTCC
19 device prior to the end of the project. WTCC has 2 goals in this process:

- 20 1. This will enable WTCC full ability to engineer and maintain a backup database of
21 HVAC/BAS files.
22 2. Allows contractors access to support their installation outside the college network by using
23 their specific software tools.

24
25 Building Field Controllers

26
27 Overview

28 At the equipment level, the Direct Digital Controlled system shall be comprised of BACnet IP and
29 MS/TP (only where controllers are not available in BACnet IP) type compliant equipment controllers. All
30 devices shall be UL listed, FCC approved, and BACnet. New supervisory controllers that require
31 software licensing and software maintenance agreements (SMAs) are not permitted. WTCC intends to
32 maintain licenses for the enterprise BAS (FIN) and other enterprise software applications including
33 analytics and dashboarding.

34
35 At the building level, BACnet building controllers (B-BC) that do not require software licensing shall be
36 used with high level field controllers such as BACnet advanced application controllers (B-AAC) and
37 lower level BACnet application specific controllers (B-ASC) to perform BAS functions. The contractor
38 shall provide enough B-BC, B-AAC and B-ASC capacity, both in number of controllers and computing
39 power, to perform BAS functions in the project.

40
41 Prior to programming controllers, the BAS Controls contractor shall request a meeting with WTCC. At
42 this meeting, WTCC will provide some or all of the following information:

- 43 a) Point Library Schematic and Point Library Table,
44 b) Critical and Non-Critical Alarming requirements,
45 c) Trending requirements,
46 d) Schedule requirements,
47 e) WTCC TC/IP Network Requirements,
48 f) A defined range of BACnet device ID numbers to use on the project, and
49 g) A Metering Standard.

50 Product Installation Requirements

- 51 A. Installation of the system shall be by qualified employees of the BAS controls manufacturer, or its
52 exclusive authorized representative, or qualified subcontractor. Direct supervision of BAS work being
53 performed by non-qualified contractors is required.
54 B. The installing contractor shall provide all tools, testing and calibration equipment necessary to ensure
55 reliability and accuracy of the control system.
56 C. All equipment, components, hardware, software and ancillary devices shall be new and fully warranted
57 for material and labor as required by the state of North Carolina and (WTCC) procurement
58 requirements. In no event shall product or service warranties be less than 1 year from acceptance of
59 the project the WTCC project manager.

DDC Software

BAS Contractor shall load all attendant software required to remotely support, troubleshoot and backup the building level BAS on the ET-BAS server at WTCC (e.g. Distech package files, JCI FX package files) to maintain and remotely support all BAS components.
Authority to specify these systems has been granted under College Construction Delegation Authority.
Justification: Software is currently in use by the college and is open to multiple vendors to install and service.

Approved field controller software is listed below:

Distech – EC-GFX

Facility Explorer (FX) - CCT

Communication

Local Ethernet Port

The local Ethernet port of the BAS field panel or controller shall be capable of supporting network speeds no lower than the 10/100Base-T standard. If faster communications are required to interface with the enterprise BAS through the WTCC IT network, Contractor is responsible for installing such devices.

BAS Data Updates

The BAS system must be capable of updating a COV from any point on the system across the network to the WTCC enterprise server with less than 10 seconds of latency at all times.

BACnet IP

The building level BAS must include the ability to perform all functions via BACnet IP. Once the BAS is integrated to the EMIS Server, the BAS Contractor shall participate in performance testing and tuning BAS components. Potential issues include, but are not limited to polling intervals, or field controller processor and memory performance.
All upstream communication to the enterprise server shall be via BACnet IP, or, if required to prevent overloading the IT network infrastructure, a more efficient communication protocol (e.g., TCP/IP).

DDC Controls

General

The controls contractor shall be responsible for all new controllers, control devices, control panels and enclosures, controller programming, controller programming software, controller input/output and power wiring and controller network wiring.

Sensors and Input Hardware

The following devices shall be provided in accordance with Division 23 requirements.

1. Field-Installed Temperature Sensors
2. Current Transducers
3. Input Switches

Override at Field Controller

B-BC and B-AAC field controllers must allow override of writeable points directly at a local controller display. No external hardware or software is required.

Electrical High/Low Voltage Distribution

1. Transformers
2. Surge and Transient Protection
3. Wiring

Data Requirements

Refer to the WTCC Point Library and Point Library Table for BAS data requirements.

Alarms

All alarms are programmed by MSI.

Alarming Overview: (Contractor shall obtain Alarm priorities from the WTCC Project Manager) These alarms will be synched to the EMIS using standard BACnet protocol when the field controller is connected

to the network. Notifications of these alarms will be sent out via FIN front end. Alarm extensions shall be created and prioritized according to (WTCC) BAS Alarm Standards. Operators with sufficient privilege shall be able to read and write alarm parameters for all standard BACnet alarm types. Operators with sufficient privilege shall be allowed to change routing (BACnet notification classes) for each alarm including the destination, time delay, priority class, day of week, time of day, and the type of transition involved.

Alarms shall be programmed with time delays and other logic to prevent nuisance tripping. Elimination of nuisance alarm notifications is a priority at (WTCC).

In order for alarm notifications to be sent to the correct email recipients, the Designer and Contractor shall use BACnet alarm levels shown in the BACnet Alarm Level – Notification Table below.

Table 4.2 BACnet Alarm Level – Notification Table

BACnet Alarm Level	WTCC Alarm Priority	Notification
10	A1	Email sent to WTCC & MCSP. Call center notified.
15	A1 & IT	Email sent WTCC, MCSP. Call Center & IT notified.
20	A2	Email sent to WTCC & MCSP.

Use BACnet notification class divisions to assign priorities to alarms and use the Alarm Level Mapping shown in [Table 4.2a](#) below for alarm notifications.

Critical Alarms

(WTCC) maintains a Critical Alarm List. Contractors shall obtain the current list from the WTCC Project Manager. [Table 4.2a](#) below displays a list of Critical Alarms that shall be programmed into each B-AAC or B-BC.

Coordinate all critical alarms with WTCC, including critical alarms for the building.

Table 4.2a Critical Alarms Table

System Type	Alarm Type	Alarm Specifications	Delay (In/Out)	Priority
	IT-MDF Room High Temp	Upon activation	None/None	A1

Default Alarms

Default alarms will be programmed and visualized in SkySpark. See WTCC BAS Guidelines in Appendix A for more information.

BACnet Instance Numbers (BACnet ID)

There must be no duplication of BACnet Device ID's. Contractor shall obtain a range of BACnet device IDs for use on each project from the WTCC Project Manager and the BAS Controls Engineer.

DDC Software Backups

Overview

Prior to project acceptance by the WTCC project manager, a backup file of all DDC field controllers shall be created and turned over to WTCC. This file shall be generated by upload and contain programming for each field controller as it exists on the date of project acceptance.

Execution/Workmanship

Enclosures

Control equipment panels shall be designed, fabricated and installed in accordance with the codes and standards referenced in this Standard, the project specific requirements (Division 23), and the following:

- a) Enclosures shall facilitate the mounting of gauges, switches, pilot lights, and the like, on the face panel when required. Control devices that are mounted on the face of the panel (e.g. meters) shall be identified with engraved nameplates.
 - i. Panels shall be UL508A compliant
- b) All wiring in panels shall be labeled at termination points.
- c) Power Transformers: Step-down power transformers shall be provided for all DDC controllers and associated accessory devices as required. Transformers shall be sized and selected to accommodate all connected accessory items. Transformers shall be UL Listed Class 2 type with 120 VAC primary, 24 VAC or VDC secondary.
- d) Controls wiring: All wiring shall be installed in a neat and professional manner. Control wiring shall not be installed in power circuit conduits or raceways unless specifically approved by the WTCC project manager for that purpose.
 - i. All wiring shall be plenum rated cable where concealed and in EMT conduits when exposed.

Write Levels from FIN

The Contractor must understand that all Actions from FIN to the BAS are set to haystackWrite / bacnetWrite level **in9**. If the BAS issues commands at write levels with precedence under **in9**, these commands cannot be changed by the enterprise BAS (FIN). The following convention generally applies to BAS at WTCC.

- Normal BAS operations are written at **in16 and shall not be written in9**.
- Software points are generally written at **in10**.
- All FIN Actions are entered at **in9**.

Scheduling

Request Building/Equipment default weekly Schedule from WTCC BAS Controls Engineer through your WTCC PM.

Point Naming

Follow the WTCC BAS Point Library Table and BAS Point Library Schematic.

PART 2 - PRODUCTS

SYSTEM DESCRIPTION

Provide a peer-to-peer networked, stand-alone, distributed processing global HVAC Control System utilizing dedicated network system.

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.

DDC system shall use ANSI/ASHRAE Standard 135-2012 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol. Comply with ANSI/ASHRAE Standard 135-2012 for all controls hardware and software.

JOB CONDITIONS (ENVIRONMENTAL CONDITIONS OF OPERATION)

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.

Point Naming

Use of WTCC preferred naming convention and Haystack 4.0 Naming Convention.

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:

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 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: Fahrenheit.

Local operator interface to provide for download from or upload to operator workstation or diagnostic terminal unit.

1 I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that
2 shorting will cause no damage to controllers.

3
4 Digital (Binary) Inputs: Allow monitoring of on-off signals without external power.

5
6 Pulse Accumulation Inputs: Accept up to 10 pulses per second.

7
8 Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance
9 signals.

10
11 Digital (Binary) Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or
12 normally closed operation with three-position (on-off-auto) override switches and status lights.

13
14 Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20
15 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.

16
17 Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type
18 electronic actuators.

19
20 Universal I/Os: Provide software selectable binary or analog outputs.

21
22 Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads
23 to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be
24 full-wave rectifier type with the following:

25
26 Output ripple of 5.0 mV maximum peak to peak.

27 Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load
28 changes.

29
30 Built-in over-voltage and over-current protection and be able to withstand 150 percent overload for at
31 least 3 seconds without failure. Transformer shall have reset function.

32
33 Units shall be multi-channelled for terminal units when provided by BAS contractor.

34
35 Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers
36 with the following:

37
38 Minimum dielectric strength of 1000 V.

39
40 Maximum response time of 10 nanoseconds.

41
42 Minimum transverse-mode noise attenuation of 65 dB.

43
44 Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

45
46 Diagnostic Devices:

47
48 Each CU shall be supplied with connections to which maintenance personnel can connect portable
49 diagnostic operator's terminals (PDOT's) for data display, setpoint modification, and reloading and
50 modification of controller programs.

51
52 Spare Equipment: Provide spare control unit boards and spare I/O boards as required. It shall be possible for
53 trained Owner personnel to replace CU boards and load software via a workstation or PDOT:

54
55 Provide two spare control unit boards. If power supplies are separate, supply separate power supplies
56 and other parts to make at least two complete sets of DDC control equipment spares.

57
58 If I/O boards are separate from the CU boards, provide four spare I/O boards for each spare CU board
59 provided above.

BAS submittal shall include extra points per controller to ensure coverage for point failure or future expansion. Each controller shall have at least 2 extra inputs and 2 extra outputs, or 10% spare, whichever number is greater.

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.

Spare I/O capacity shall remain on all devices for future expansion.

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

5°F above high setpoint of comfort zone

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:

Refer to Appendix of skyspark rules.

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.

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.

Additional application control requirements shall be met as required by the DDC control logic diagrams on the Drawings.

CABLING AND WIRING

DDC Cabling: **Network cabling within buildings shall be CAT 6.** 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

All cables within plenum shall be plenum-rated cables complying with NFPA 262. Circuits must meet NFPA 70 Class 2 (current-limited) requirements. All cables shall be UL-listed for the application.

Data Cable:

Ethernet Cable shall be CAT6a, Blue Jacket, (BAS) shall be printed on jacket every 6 feet, and shall use T568B connector pin order.

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 stranded 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. Control conduits shall be yellow in color. 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. Color code per Div 26.

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. 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 including electrical or mechanical equipment rooms CMU walls. Raceway serving surface mounted equipment (control cabinets, VFDs, etc.) in electrical or mechanical equipment rooms may be surface mounted on CMU walls.

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.

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. Label cover with "BAS".

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), including a listing of BACnet Interoperability Building Blocks (BIBBs) utilized. The PICS is a written document, created by the OEM, that identifies the particular objects and options specified by BACnet that are implemented in the OEM controller/gateway, utilizing the ANSI/ASHRAE Standard 135 format.

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.

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 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 wiring. 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.

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.

Prior to completion of field tests and inspections contractor shall submit a report to WTCC documenting results of all tests.

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 temperature instruments and material and length of sensing elements.

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. Include identification of electrical circuit feeding control panel.

Verify that spare I/O capacity has been provided.

I/O checkout and sensor calibration.

BAS will also perform I/O validation with MSI

Verify that DDC controllers are protected from power supply surges.

Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

Prior to completion of field tests and inspections contractor shall submit a report to WTCC documenting results of all tests and documenting any calibration values that had to be input to sensors.

CALIBRATION AND ADJUSTMENT

General:

Make three-point calibration test for both linearity and accuracy for each analog instrument.

1 Calibrate equipment and procedures using manufacturer's written recommendations and instruction
2 manuals. Use test equipment with accuracy at least double that of instrument being calibrated.

3
4 Control System Inputs and Outputs:

5
6 Check analog inputs at 0, 50, and 100 percent of span.

7
8 Check digital inputs using jumper wire.

9
10 Check digital outputs using ohmmeter to test for contact making or breaking.
11 Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant
12 source.

13
14 Temperature:

15
16 Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-
17 resistance source.

18
19 Calibrate temperature switches to make or break contacts.

20
21 Provide diagnostic and test instruments for calibration and adjustment of system.

22
23 Provide written description of procedures and equipment for calibrating each type of instrument. Submit
24 procedures review and approval before initiating startup procedures.

25
26 Adjust initial temperature set points.

27
28 Checkout, calibration, adjustment, and point to point (from sensor to BAS graphic) validation of all circuit to be
29 monitored with electrical metering system.

30
31
32 **VERIFY SENSOR ACCURACY**

33
34 Test all temperature sensors.

35
36 Sensor calibrating instruments shall be used in checkout of the overall performance. The sensors of
37 these instruments shall be placed at the proximity of DDC system sensors to indicate the conditions of
38 the controlled media (air, water, etc.). A preliminary evaluation shall be made as to the suitability of
39 having the DDC system sensors checked in-place or they may be placed in simulated environment. If
40 the response times of the two sensors (DDC system sensor and calibration sensor) are similar, testing
41 may be performed with the sensors in place. If the conditions of the controlled media change slowly,
42 testing may also be performed with the sensors in place. However, if the conditions of the controlled
43 media change rapidly and the time responses of the two sensors vary considerably, testing shall be
44 done with the sensors placed in a known environment such as a temperature bath.

45 Verification procedures: Verification of sensor accuracy shall be made using the following procedures.
46 Compare readings for each sensor from the calibration instrument and the DDC system to determine if
47 the measurement accuracy meets the requirements of Section 230913.

48
49 Temperature: Use a multi-point verification check at various points in the operating range
50 (including minimum, typical, and maximum), utilizing a calibrated thermometer and Dewar flask
51 or a calibrated portable drywell ($\pm 0.5^\circ\text{F}$) temperature probe calibrator.

52
53
54 **VERIFY FINAL CONTROL ELEMENT FUNCTIONALITY**

55
56 Test each final control element operator to ensure performance in accordance with Section 230913 and the
57 control sequences defined on the Drawings. Test shall include full range of movement, stability through that
58 range, and power and/or control signal failure performance. Operators found to be non-functional in any way
59 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, printer output, 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.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

HVAC Controls contractor shall perform training on all BAS field devices. MSI shall perform training for Enterprise software/graphics.

Initial Training: BAS and MSI training should only take one day. (Up to 8 hrs. 4 hrs. for each training session.) BAS onsite training itinerary should include physical tour, software sequence review, and review of Controls As-built. MSI virtual training itinerary should include Connectors, Logic Programs, and End User Apps.

- Alarms/Overrides
- Graphics
- O&M Manuals
- Point Graphics
- Schedules/Holiday Button
- Summaries

Six-month post occupancy training: Building Level BAS virtual training – to last up to 4 hrs.

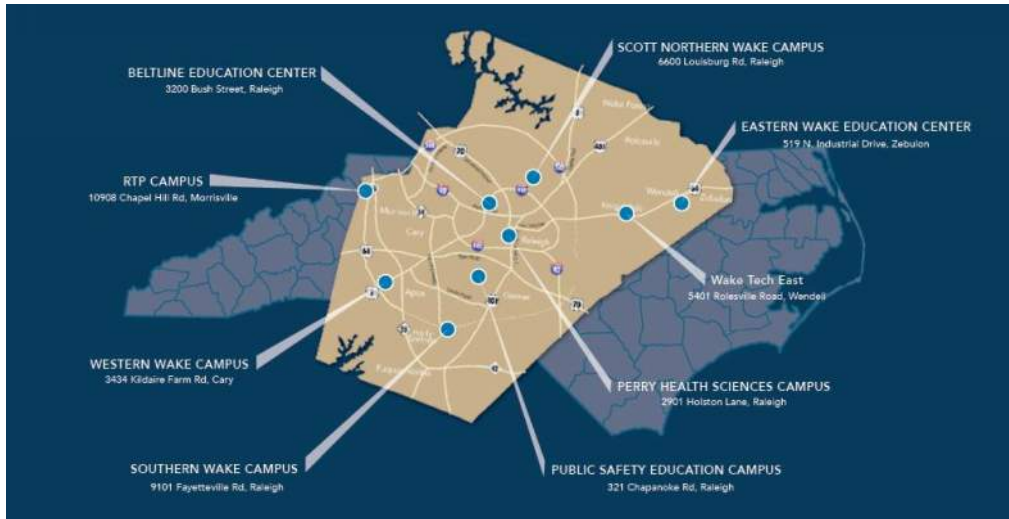
END OF SECTION 230923

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APPENDIX A

WAKE TECH 23 C BAS GUIDELINES (rev 12-5-24)

RECEIVED
03/25/2025
SAMET



Wake Technical Community
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Mechanical Project Manager

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Commissioning Engineer

Director – Facilities Operations

Director – Facilities Management

Director – Design & Construction

Vice President of Facilities

Executive Director of Facilities

IT Network Operations Manager

IT Cybersecurity Manager

Maintenance Contracted Service Provider (MCSP)

BAS Controls Technician – South

BAS Controls Technician – Central

BAS Controls Technician – North

Note

Sections highlighted in yellow indicate changes from the previous edition of this guideline.

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4.7.9 Appendix B: Summary of Approved Meters

4.7.10 Appendix C: Definition of Units for Measurement

Figure 1 – BAS Connected Systems Chart

Figure 2 – Wake Tech BAS Network Architecture.....

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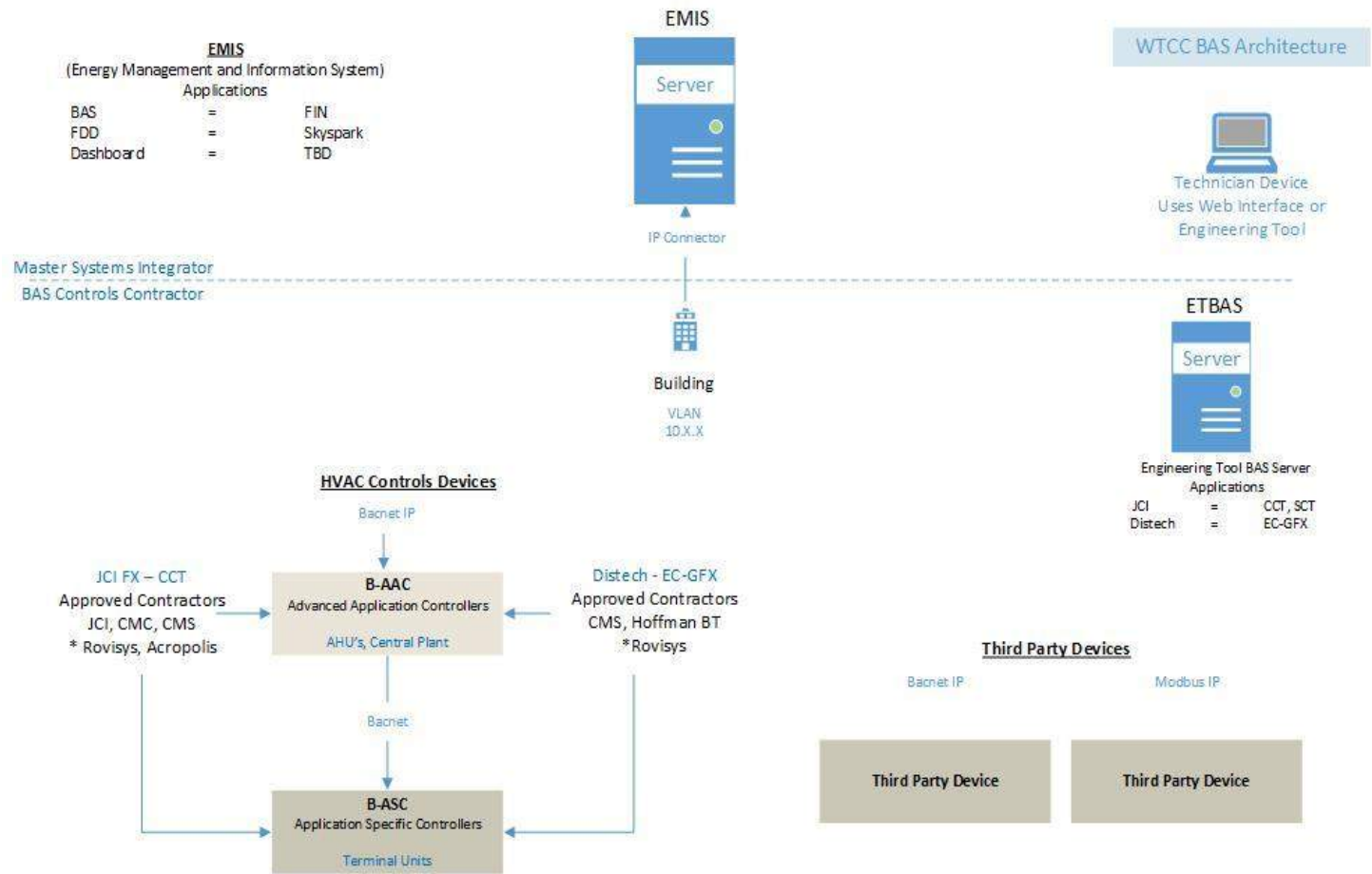
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Figure 3 - Field Controllers Schematic

Attachment 1 – BAS Point Library Table

Attachment 2 – BAS Point Library Schematic

Attachment 3 – FIN Point Library Update Procedure

Attachment 4 – BAS-MSI Coordination Spreadsheet

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1. General Overview

The Building Automation System Guidelines (BAS Guidelines) are intended to provide design professionals, Master System Integrators (MSI), BAS Contractors (BAS), Commissioning Agents (CX), service personnel, facility operators and others involved in building operations at Wake Tech with an understanding of the fundamental requirements of the Building Automation System (BAS). For Capital Projects the BAS architecture shall include Enterprise Level BAS communicating via BACnet IP to Building Level BAS (Field Controllers) and BAS Connected Systems. For Renovation projects, supervisor controllers may be required. When required, guidance is provided in section 4. Consult with Wake Tech and Controls Engineer during DD phase. The BAS shall be an open protocol, BACnet communication-based system which can be maintained and modified by Wake Tech Facilities and Maintenance Contracted Service Provider (MCSP) controls technical and HVAC staff. This effort to standardize requires the strict enforcement of these criteria in order to utilize the existing BAS systems and infrastructure currently in place at Wake Tech. Justification for technical requirements in this specification are on record within the college and will show documented savings in training, spare parts and management costs associated with the highly technical systems which impact Life Safety, EHS, and Energy Consumption on all Wake Tech campuses.

The BAS Guideline not only addresses the requirements of a traditional BAS but also governs the sharing of data with related energy management and information systems (EMIS) applications such as energy information systems (EIS), analytics including fault detection and diagnostics (FDD), and automated system optimization (ASO) tools. For this reason, Wake Tech BAS Guidelines cover both Division 23 – HVAC and Division 25 – Integrated Automation. This BAS Guideline is intended to evolve over time because building operations tools and practices rely on technology that can change rapidly.

The BAS Guideline shall apply not only to new construction but also renovation, repair and replacement of mechanical systems, electric power, and other utility services at all Wake Tech campuses and facilities.

- Attention ME Engineer. When mechanical renovation design affects a “legacy” BAS field controller, Wake Tech intends for BAS controller to be upgraded.
Reason. BAS contractor installers usually do not keep “old” software on laptops to perform work.
- Attention ME Engineer. Engineer to meet with Wake Tech for coordination meeting to ensure these BAS Guidelines have been reviewed and incorporated by the Designer into the plans and specifications.

[Figure #1 - BAS Connected Systems Chart](#)

[Figure #2 – Wake Tech BAS Network Architecture](#)

[Figure #3 – Field Controller Schematic](#)

1.1 Approved Master System Integrator (FIN) Integrators

1. Essex Consulting Group
2. CMS
3. Building Controls & Solutions
4. Others as approved

1.2 Approved Analytics Software (SkySpark) Integrators

1. Essex Consulting Group
2. CMS
3. Building Controls & Solutions
4. Others as approved

1.3 Approved Dashboard Software (TBD) Integrators

1. Essex Consulting Group
2. CMS
3. Building Controls & Solutions
4. Others as approved

1.4 Approved Building or Site Level - Field Equipment Control Manufacturers

Distech Controls
Facility Explorer (JCI)

Field equipment controllers (FEC) shall be BACnet IP or BACnet MSTP compliant. Field controllers should have BACnet Testing Labs (BTL) certifications as B-AAC (BACnet Advanced Application Controller), B-ASC (BACnet Application Specific Controller), or B-BC (BACnet Building Controller) devices.

Building Supervisory Controllers that require software licensing and ongoing service maintenance agreements are expressly prohibited (e.g. N4 JACEs). This prohibition also extends to BAS servers functioning as a building level supervisory controller that require ongoing software licensing or service maintenance agreements (SMAs).

In order to improve communication with enterprise software (BAS, analytics, dashboarding or other functions), the BAS Contractor shall consider using middle-ware devices in buildings to communicate downstream to field controllers (Third Party Equipment) and upstream to enterprise software using BACnet communication protocols.

1.4.1 Approved BAS Installers

BAS equipment shall only be installed by companies who are current, actively licensed VARs (value added resellers) or VADs (value added distributors). Wake Tech approves these installers: Comfort Mechanical Contractors (CMC), CMS Controls, Hoffman Building Technologies, and Johnson Controls (JCI-FX).

*These Installers may be used on smaller projects with approval from Wake Tech:

Acropolis and Rovisys.

1.5 Designer Drawing Requirements

1.5.1 Design Drawings Required.

1.5.1.1 Floorplans

Equipment, Ductwork, Piping, Controls – per floor or per floor section.

1.5.1.2 Mechanical Details

1.5.1.3 Sequence of Operations

1.5.1.4 Control Schematics

1.5.1.5 Misc. Schematics for BAS Connected Systems.

Include Input/Output Chart and Responsibility Matrix.

1.5.1.6 1 Yr. Post-Occupancy Review/EUI Baseline Benchmark

EUI Baseline will be compared to 1 yr. post-occupancy utility usage information to determine if engineer design was met. If utility usage was higher than the EUI baseline, suggestions and corrective actions will be taken to alleviate discrepancies. Refer to Div. 01 01 13 for the latest release of the *Energy Design & Management Guidelines* for further details.

1.6 Control Submittals.

The following required information shall be included in BAS Control submittal.

1.6.1 Title Page

1.6.2 Table of Contents

1.6.3 Symbols and Abbreviations Legend/ Wiring Termination Standards

1.6.4 Bill of Materials – per controlled system

Can be included on other pages.

1.6.5 IT Network/BAS Network Architecture Layout

1.6.6 Floorplans (per floor)

Show locations of all equipment/controllers.

1.6.7 HVAC Equipment Drawings

Sequence of Operations.

Control Panel Layout- one for each Pane.

Control Points List- one for each Device.

Complete Wiring and Schematic Diagrams.

1.6.8 Third Party Equipment Drawings

- Wiring details
- Communication details

**Terminal identification for all control wiring shall be shown on the Wiring and Schematic Diagrams.

1.6.9 Schedules

- Network
Information to include Controller Name, Location, Communication Protocol, IP Address, MAC address, BACnet Network Number, BACnet Instance ID, Controller Type, System, Description.
- Damper
- Control Valves
- Terminal Unit
 - Include Zoning Information in schedule.
This helps the MSI to build Floorplan Graphics
 - ME Designer to include ACH's (Air Changes per Hour) for Lab Spaces.
- Flowmeters
- Multi-Tap Transformers. (If used)
- VFD's/ Starters/ Disconnects

** Submittal drawings shall also contain software descriptions, calculations, and any other details required to demonstrate that the system has been coordinated and will properly function as a system.

1.7 As-built Control Drawings

When submitted as Closeout Documentation, BAS Controls Engineer will review (within 3 weeks). Any corrections requested by Wake Tech will be made by BAS contractor and resubmitted. Visio files used to create As-built control drawings should be submitted to Wake Tech for any future renovation updating.

23 C BAS Guidelines (rev. 12-05-2024)

This should be method for furnishing as built control drawings inside controls cabinets for all major systems/equipment for new/renovated controls projects.

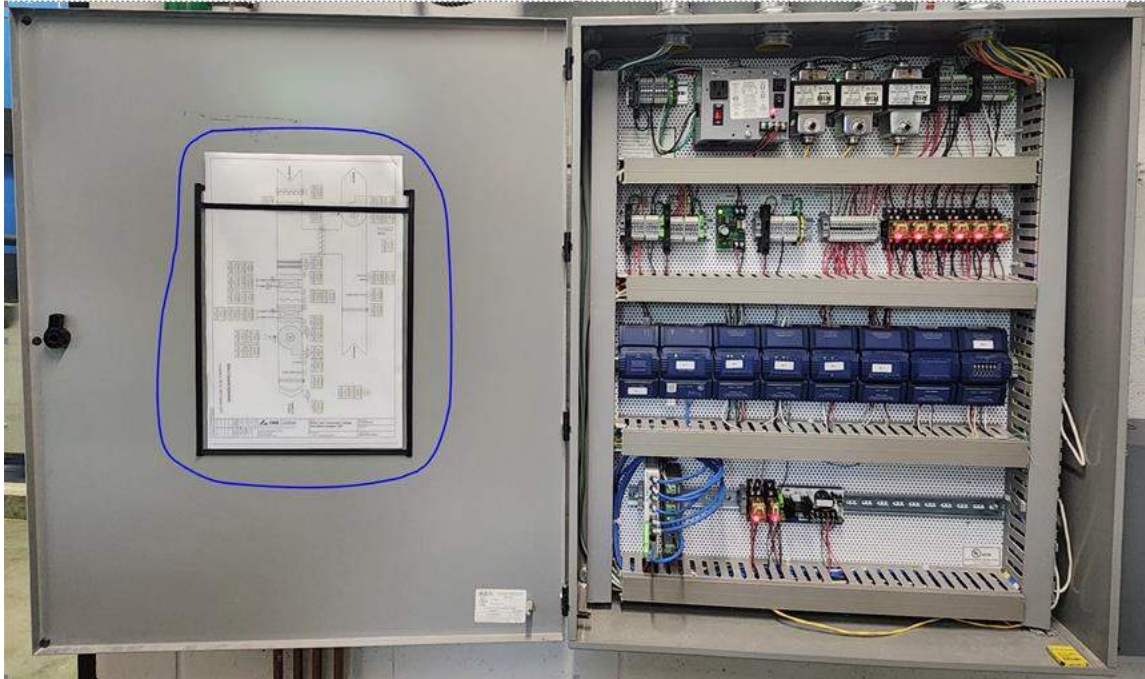
Typical literature included (if available - drawings do not need to be laminated):

Systems Control Schematic(s)

Controller Module I/O Layout(s)

Systems Sequence of Operations

Other pertinent information (Safety Circuit Wiring, Control Panel Layout(s))



1.8 BAS Connected Systems – Submittals

Equipment submittal shall include Communications protocol information.

Equipment submittal shall include BACnet Points Lists.

1.9 Commissioning

1.9.1 New Work

Commissioning References shall be included in Div. 1, Div. 22, Div. 23, Div. 25, and Div. 26.

All BAS controls and interfaces associated with commissioned systems shall be developed with Wake Tech during DD/CD phase of design. BAS Enterprise Graphics to be used to perform CX review.

1.9.2 Renovation Work

Wake Tech will evaluate the amount of CX required in DD phase per project.

1.9.3 1 yr. Post Occupancy EUI Review

Refer to Energy Design Management Guideline (current revision). Wake Tech 1.3.8 Post Occupancy review. Wake Tech requires a 1 yr. post-occupancy review of Utilities to determine if design EUI was achieved.

1.10 Test & Balance

1.10.1 New Work

Mechanical Contractor shall employ a Test & Balance contractor to balance all mechanical systems to the performance specifications on plans. Report shall be completed and submitted prior to the completed checkout of Commissioning Functional Tests.

Additional T&B required, per engineer's request, after review of the initial report shall be provided at no additional cost.

T&B report to be completed by an independent, certified T&B Contractor.

Instruments used for balancing shall remain in calibration during T&B portion of project.

1.10.2 Renovation Work

In addition to the requirements of New Work, Wake Tech requires a pre-design combined pre-demolition Test & Balance Report and BAS Controls diagnostic report on the existing controls system.

T&B Report shall include:

- air and water flows
- entering and leaving air conditions
- external and total static pressures
- all performance and controls deficiencies discovered.

Controls BAS Report shall include:

- Any equipment or component found to be inoperable or short of design capacities shall immediately be brought to the attention of the engineer.

Summation of grilles is an acceptable alternative to duct traverse readings.

Pre-demolition T&B Report to be completed by an independent, Certified T&B Contractor.

Pre-demolition Controls Diagnostic Report shall be completed by the MSI Integrator and/or BAS Contractor.

Combined Mechanical pre-demolition Report shall be submitted for review during pre-design process.

1.11 Training

1.11.1 Project Close out Training.

BAS and MSI training should only take one day. (Up to 8 hrs. 4 hrs. for each training session.)

BAS onsite training itinerary should include physical tour, software sequence review, and review of Controls As-built. MSI virtual training itinerary should include Connectors, Logic Programs, and End User Apps.

- Alarms/Overrides
- Graphics
- O&M Manuals
- Point Graphics
- Schedules/Holiday Button
- Summaries

1.11.2 6-month Post Occupancy BAS Training

Building Level BAS virtual training – to last up to 4 hrs.

1.12 Work Execution – Warranty and Licensing

1.12.1 Licensing

All hardware, software and licensing of BAS and related components including analytics and dashboarding systems, shall be provided by Installer for a period of three years (36 months) from date of project acceptance by the Wake Tech Project Manager.

1.12.2 Warranty

The BAS installed under this Guideline shall be free from defects of material, and workmanship under normal use and service for a period of 12 months after final acceptance by the Owner. Wake Tech contracts one MSCP to have full responsibility for maintaining the BAS. If within the 12-month warranty period, any equipment, software, or labor is found to be defective in workmanship or materials, it shall be replaced by the BAS Controls installer at no cost to the owner. BAS contractor shall return to the site during the 11-month walk through to perform Temp and Humidity calibrations on 10% of the devices as directed by the owner.

Warranty service calls shall be available to the job site during normal working hours.

1.12.3 Preventative Maintenance

- Manufacturer's Field Services: Provide the services of a factory-authorized service representative to start control systems. Shall be scheduled with owner.
- Test and adjust/calibrate controls and safety.
- Replace damaged or malfunctioning controls and equipment.
- Start, test, and adjust control systems.
- Demonstrate compliance with requirements and provide results of pre-functional and functional field testing in a report.
- Adjust, calibrate, and fine tune circuits and equipment to achieve the sequence of operation specified without fault or failure.
- All tools, Testing, and calibration equipment necessary to ensure reliability and accuracy of the controls system shall be supplied by controls contractor.

1.13 Close out documentation

- a) Include Wake Tech Mechanical Engineer, Energy Director, BAS Controls Engineer, and Commissioning Engineer in as-built MEP and Control drawings review meetings.
- b) All BAS controls devices removed from Building Network Architecture shall be returned to the Wake Tech PM as part of the Attic stock turnover with transaction paperwork as documentation.

1.14 Codes Compliance

All work performed shall conform to City, County, State, and Federal regulations, and codes in effect as of the date of Contract.

1.15 Permits

Except as otherwise indicated, the Controls Contractor shall secure and pay for all permits, inspections, and certifications required for work and arrange for all necessary approvals by the governing authorities.

1.16 National Codes and Standards

- a) NFPA 70 – National Electric Code (NEC)
- b) ASHRAE - American Society of Heating, Refrigeration, and Air-Conditioning Engineers
- c) ANSI/ASHRAE Guideline 36 – High-Performance Sequences of Operation for HVAC Systems
- d) ANSI/ASHRAE Standard 62.1 – Ventilation, IAQ

- e) ANSI/ASHRAE Standard 90.1 – Energy Standard for Buildings
 - f) ANSI/ASHRAE Standard 135 – BACnet: A Data Communication Protocol for Building Automation and Controls Networks.
 - g) UL 916 – Standard for Energy Management Equipment
 - h) Project Haystack. Project-haystack.org
 - i) FCC – Part 15, Subpart J
- City, County, State, and Federal regulations, and codes in effect as of the date of Contract.

1.17 Coordination of work between Division 23 & 25

1.17.1 Overview

The EMIS at Wake Tech shall be developed by an MSI via open collaboration with the BAS contractor and equipment manufacturer(s). The EMIS at Wake Tech shall be functionally tested by the CX Agent. The goal is to have this coordinated work complete prior to building Commissioning. BAS/MSI milestones should be included in construction schedules and in OAC meetings. EMIS consistency shall be maintained with every project integration. On all projects Wake Tech prefers one company, ideally either GC or Mechanical Contractor, to contract both BAS and MSI companies. Wake Tech has developed a spreadsheet template that can help either GC or Mechanical Contractor to manage the coordination of this work.

The Mechanical Engineer shall apply a Responsibility Matrix for all systems included in the BAS.

See [Attachment 4](#) for more information.

1.17.2 Division 23 Scope of Work

BAS contractor shall provide all work under Division 23. All building level controllers/host devices shall be connected to Wake Tech BAS VLAN network, via DHCP, for integration into EMIS. Further guidance found in Section 4.

1.17.3 Division 25 Scope of Work

MSI contractor shall provide all work under Division 25. MSI shall integrate point data from building level controllers into EMIS. (FIN, Skyspark, and Dashboard software's). Further guidance can be found in Section 3.

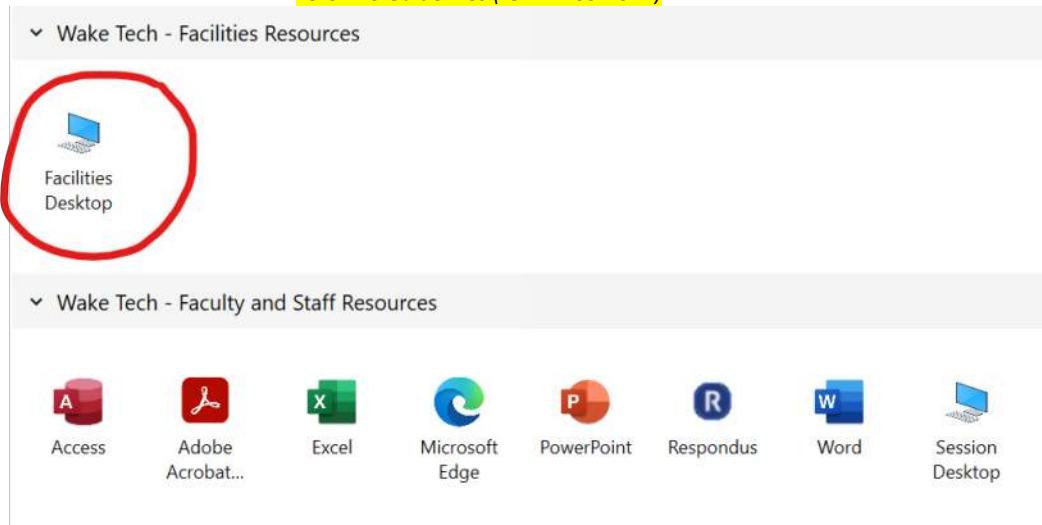
2. Wake Tech Information Technology – IT

2.1 Overview

BAS systems must comply with Wake Tech's IT network and cybersecurity policies. As these policies and network architecture are subject to change, it is the Designer's, MSI Integrator, and BAS Contractor's responsibility to obtain and comply with current requirements.

2.2 Network Access

- All persons requiring network access shall coordinate through Wake Tech BAS Controls Engineer.
- Contractors will need to submit paperwork to obtain a Wake Tech Key Account.
- Wake Tech IT will create Key Account and provide permissions to access;
 - WVD / Facility VM.
 - RDC onto specific BAS Servers.



- Access shall be maintained through the Warranty period.
- Passwords are valid for 365 days.
- FYI – requirements to maintain an active account status.
 - Completion of yearly Online Cybersecurity Training.
 - Inactivity of 45 days on network will disable account.

2.3 Human Resource Background Check

All contractor opportunities at Wake Tech may be contingent upon satisfactory results of a criminal background check, consult with the Project Manager (PM) for guidance.

2.4 Private BAS Subnet VLAN's

Wake Tech IT Network is a segmented MAN (Metropolitan Area Network). Every building on each Campus is separated into different broadcast areas by gateways.

- BAS network controllers (Host Devices) will communicate on a BAS VLAN
 - Wake Tech IT will provide 2 Owner Network Drops at ONE LOCATION.
 - BAS Contractor to use one Network Drop.
 - Second Network Drop shall be reserved for Wake Tech use.
- BAS network controllers shall use DHCP IPv4 settings.
BAS contractors will provide BAS Controls Engineer Host Device MAC address and location info prior to adding device to VLAN. This “pre-registration” will ensure all devices have reservations on DHCP server. (Similar to traditional Static settings.)
- BAS network controllers shall use DHCP DNS settings.
- Only one BACnet/IP Broadcast Management Device (BBMD) allowed per subnet.
 - Verify with Wake Tech if a BBMD is in use on subnet.
 - For Consistency choose AHU-1 controller as BBMD
- UPS – (Eaton, Industrial gateway cards) will communicate on a UPS VLAN.
No BAS integration is required.

2.4.1 Transferring Host Devices to BAS Subnet VLAN.

BAS Controls Contractor will contact Wake Tech BAS Controls Engineer prior to transferring any host device to BAS VLAN. The preferred method will be to “pre-reserve” IPs on DHCP server for host devices with the IT Networking dept. To accomplish this, BAS Contractor will inform the Wake Tech BAS Controls Engineer (2 days in advance of the day to transfer) that they have filled out the BAS Coordination Spreadsheet with device name, location, and MAC info.

For individual device transfers that did not provide a 2-day notice, Wake Tech cannot guarantee “same-day” accommodations.

2.5 Ethernet Cable Requirements

- CAT6 is preferred ethernet cable size.
- Blue Jacket
 - Cable shall have (BAS) printed on jacket every 6 feet.
 - Windy City provides a cable with this listed on jacket.
- T568B connector pin order

2.6 Outside Devices

No laptops outside the management of Wake Tech IT shall plug into Wake Tech Network due to security concerns.

Router ACL's will isolate BAS VLAN causing all other devices to stop communicating.

2.7 Specific Field Equipment Controller Software

All new specific field equipment controller software to be loaded and licensed onto a Wake Tech device prior to the end of the project. Wake Tech has 2 goals in this process:

1. This will enable Wake Tech to have full ability to engineer and maintain a backup database of HVAC/BAS files.
2. Allows contractors access to support their installation outside the college network by using their specific software tools.

Coordinate the loading of field equipment controller software with the BAS Control Engineer.

All Projects. BAS contractor to provide software updates on owner-maintained software when controllers in project are installed with firmware higher than firmware on owner software. Discuss in Controls kickoff meeting.

2.8 Active Directory (For Future Consideration)

2.8.1 LDAPv3, SSO

Wake Tech requires future logins for BAS equipment to comply with LDAP, SSO security protocols.

3. EMIS – Energy Management Information Systems

3.1 EMIS Overview

Energy Management and Information Systems – hosts a broad family of software tools and services to manage institutional buildings energy usage. These technologies include, for example, energy information systems, building automation systems, equipment-specific fault detection and diagnostic systems, benchmarking and utility tracking tools, automated system optimization tools, and building dashboards. Wake Tech maintains licenses for the Enterprise Level BAS (FIN) and other enterprise software applications including Analytics (Skyspark) and Dashboarding (TBD).

3.2 Virtual Server Requirements

The EMIS server is currently running Windows Server 2016.

3.3 FIN Stack Framework Software

3.3.1 Current Software Version

The college maintains the firmware version of FIN Stack Software running on EMIS Server. Host capacity -Point License will be evaluated on every project to ensure coverage for new points integration.

3.3.1.1 Examples of Information that may be provided to Designer for Specifications:

1. **License**

Is based on points, which are called “Caps” under FIN’s licensing language.
Caps can have a history or not.
Wake Tech’s FIN license capacity is 127,000.

2. **Service Maintenance Agreement**

College maintains FIN-SMA under separate budget.

3.4 Enterprise BAS Application - FIN

3.4.1 Overview

Wake Tech manages Enterprise BAS via FIN Stack (FIN), developed by J2Innovations – a wholly owned subsidiary of Siemens AG, as the BAS enterprise software hosted on a Wake Tech EMIS server. FIN is designed to be open, supporting all the major protocol standards used in buildings today, to enable integration with multiple building level systems and IoT deployments.

The Master System Integrator (MSI) shall integrate from the Building Level BAS (Field) controllers and BAS Connected Systems Gateways to the existing Enterprise Server. Wake Tech requires the Master System Integrator (MSI) to be a FIN Certified Integrator with experience integrating through BACnet and nHaystack connections.

Figure #1 - BAS Connected Systems Chart

It is Wake Tech’s goal to integrate from high level field controllers (e.g., a B-BC or B-AAC) or Gateways (middleware devices) to a FIN enterprise server which will be a single front-end to view graphics, and interact through point overrides, and to manage alarming, scheduling, and trending (AST). FIN leverages project Haystack open-source metadata protocols by using tagging to automate configuration processes and deliver context-sensitive information to give a highly intuitive user experience. This allows building systems from various distributors to be integrated into a unified system in order to provide flexibility for expansion, maintenance, and service of the BAS system. The Owner, Wake Technical Community College, shall be the named license holder of all software associated with any and all incremental work on the projects.

3.4.2 MSI Scope of Work

MSI shall attend CX kick-off and all CX progress meetings to ensure graphics are complete for CX Functional Testing. MSI shall meet weekly with BAS contractor to obtain network controller IP/MAC/BACnet ID info and point lists per device to perform integration. MSI will perform turnover training for graphics, alarming, scheduling, trending, and O&M documents. MSI will work with CX Agent during Functional Testing.

Post construction phase, MSI will integrate Project into Skyspark. New rules should be written for new equipment. EUI Dashboards will be updated.

*Post Analytics phase, dashboards shall be built. Connected to Marketing Displays at bldg. entrances.
(This is a future plan for the college)

3.4.3 Communication Connectors

- **BACnet**

Connector used for integration with BACnet compliant devices.

- **Modbus**

Electrical Equipment usually communicates natively Modbus.

Wake Tech prefers to integrate electrical equipment points to EMIS via BACnet Connector, conversion to occur at electrical equipment with a BACnet Gateway.

- Gateway to be supplied with Equipment.

- Gateway to be configured by Equipment supplier.
- Once integration has been completed, MSI will need to meet with vendor that programmed gateway to verify points read/write accurately.
- If equipment supplier is unable to option for a BACnet conversion, project team shall consult with MSI about performing Modbus integration.
- **Haystack**
Connector used for integration with Niagara 4 JACEs.

3.4.4 FIN Point Library Table

Wake Tech combines an internal naming convention with a Haystack 4.0 Naming Convention.

Wake Tech holds one Point Library .zine file.

File is a combination of .csv files formatted together to create an EMIS database.

The matched point will automatically be applied correct Tags.

[Attachment #1](#) contains the Point Library Table in .xls format.

Document will need to be converted to .csv for uploading to FIN.

[Attachment #2](#) contains the Point Library Table in .pdf format as a Schematic drawing.

If new equipment points are added to database, MSI will run function within FIN to combine the new points into Point Library file.

[Attachment #3](#) contains the procedure to update Point Library Table and .zinc file when new Equipment or Points are added to EMIS database. Request from BAS Controls Engineer.

Update point library table for every project that will have new equip/points. Updated point library table will be approved by Wake Tech prior to integration.

MSI shall use same naming convention for point equipment consistent across all sites. Work not consistent will be redone at no expense to Wake Tech.

3.4.5 Database (DB Builder)

3.4.5.1 Writable Points

Writable points in FIN are commanded by clicking on a Gear Icon on the graphic next to the point and choosing an Action. A gear symbol is used in FIN graphics (lightning bolt in Point Graphics window) to show that a point has actions or is writable, and the gear can be clicked on to bring up the action choices for each point to set as a "Set Value" choice in BAS software. An example is shown below for an AHU Supply Fan command.



Within FIN, Action categories are permissions with priority increasing in direct proportion to the number. That is, Permission 9 takes precedence over Permission 6 in FIN. Note that this is opposite from BACnet and Niagara where write level priority, a number from 1 to 16, is inversely proportional to the number (Niagara write level 9 overrides level 16).

The Designer and Contractor must understand that all values from FIN to the BAS are set to haystackWrite / bacnetWrite level in9.

Action category permissions work in conjunction with the user action access permission property tag which set users’ permissions at “Set” (<=9), “Manual” (<=6), and “Emergency” (<=9). FIN users are only provided Actions that are at or below their username Access permission. For example, a user with Access Permission 6 does not have access to Permission 9 Actions.

The Master System Integrator (MSI) shall recognize the following FIN Action and Permission setup and use it to integrate buildings to FIN unless notified by the Wake Tech Project Manager or BAS Engineer to use other Action settings:

String Points		Bool Points	
Default Action Display	HVAC Permission	Default Action Display	HVAC Permission
Emergency Set	9	Emergency Active	9
Emergency Auto	9	Emergency Inactive	9
Manual Set	6	Emergency Auto	9
Manual Auto	6	Manual On	6
Set Default	9	Manual Off	6
Set Null	9	Manual Auto	6

		Set Default	9
Enum Points		Numeric Points	
Default Action Display	HVAC Permission	Default Action Display	HVAC Permission
Emergency Set	9	Emergency Set	9
Emergency Auto	9	Emergency Auto	9
Manual Set	6	Manual Set	6
Manual Auto	6	Manual Auto	6
Set Default	9	Set Default	9
Set Null	9	Set Null	9

Remember - No matter what the above FIN Action Permission levels are, all FIN Actions are written to building level BAS at haystackWrite / bacnetWrite level **in9.

The above examples provide the entire FIN Action Option range. MSI, please coordinate FIN Action Options for first equipment point with Command options on point integrated from BAS controller prior to cloning multiple points to subsequent equipment.

For consistency across BAS Enterprise Graphics, Wake Tech prefers to use these Action options. Info in BLUE can be copied/pasted into Point/Writable/Actions – Editor Window.

1. Enumerated Points

```
ver:"3.0"
dis,expr,hvac_finCat
"Emergency Set","pointEmergencyOverride($self,$val)",9
"Emergency Auto","pointEmergencyAuto($self)",9
"Manual Set","pointOverride($self,$val,$duration)",6
"Manual Auto","pointAuto($self)",6
"Set Default","pointSetDef($self,$val)",9
"Set Null","pointSetDef($self,null)",9
```

2. Numeric Points

```
ver:"3.0"
dis,expr,hvac_finCat
"Emergency Set","pointEmergencyOverride($self,$val)",9
"Emergency Auto","pointEmergencyAuto($self)",9
"Manual Set","pointOverride($self,$val,$duration)",6
"Manual Auto","pointAuto($self)",6
"Set Default","pointSetDef($self,$val)",9
"Set Null","pointSetDef($self,null)",9
```

3. Boolean Points

```
ver:"3.0"
dis,expr,hvac_finCat
"Emergency Active","pointEmergencyOverride(\$self,true)",9
"Emergency Inactive","pointEmergencyOverride(\$self,false)",9
"Emergency Auto","pointEmergencyAuto(\$self)",9
"Manual On","pointOverride(\$self,true,\$duration)",6
"Manual Off","pointOverride(\$self,false,\$duration)",6
"Manual Auto","pointAuto(\$self)",6
"Set Default","pointSetDef(\$self,\$val)",9
"Set Null","pointSetDef(\$self,null)",9
```

3.4.5.2 Integration of Third-Party Equipment/Points

Overview. Wake Tech prefers to use BACnet IP communications to integrate Equipment points into FIN. Meetings with Engineers to be held during DD and CD phase to determine points integrated from equipment and how to present on graphics.

Signoff of Equipment submittal shall be coordinated with BAS controls engineer to ensure communications card and BACnet points list are included for EMIS integration.

Contact information must be included with Equipment submittal to help with integration process. I would like to have contact info for.

*Equipment supplier tech support.

*Company (equipment supplier uses for translating points from Modbus to BACnet) tech support.

After equipment submittal is approved. (with communication contact, and BACnet points list) a meeting with MSI should occur to finalize points to be integrated.

At equipment startup, after BAS contractor has put communication card on BAS VLAN and added BACnet information, the MSI shall verify (at startup) the FIN connection can be made. GC to ensure that equipment startup includes a communication technician. (usually one equipment startup tech does do communication)

See [Figure 1](#) for full list of equipment Wake Tech has integrated previously. Please include in project ME drawings this image with equipment to be integrated in current project.

3.4.5.2.1 Network Lighting Controls

<u>FIN Schedule Name</u>	<u>Notes</u>
Int Lighting	Link schedule to command able points in Lighting Controller
Ext Lighting	Link schedule to command able points in Lighting Controller

<u>FIN point name</u>	<u>Description</u>	<u>Facets</u>	<u>Interval</u>	<u>Units</u>	<u>Precision</u>
GROUP-CONTROL-Exterior	Command Point	ON, OFF	1HR, COV		
GROUP-CONTROL-Interior	Command Point	ON, OFF	1HR, COV		
Interior-Lighting	Schedule Point	Inactive, Active	1HR, COV		

3.4.5.2.2 PV Systems

<u>FIN point name</u>	<u>Description</u>	<u>Facets</u>	<u>Interval</u>	<u>Units</u>	<u>Precision</u>
enrgTot	Energy Total		15 min	MWh	1
freq	Frequency		15 min	Hz	2
inVltAB	Line Voltage AB		15 min	V	1
inVltBC	Line Voltage BC		15 min	V	1
inVltCA	Line Voltage CA		15 min	V	1
phsACur	Phase A Current		15 min	A	1
phsBCur	Phase B Current		15 min	A	1
phsCCur	Phase C Current		15 min	A	1
Ping			N/A		

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reactPwr	Reactive Power		15 min	VAR	1
totActPwr	Total Active Power		15 min	kW	1
totAppPwr	Total Apparent Power		15 min	kVA	1
totPwrFctr	Total Power Factor		15 min	pf	2

<u>FIN Graphic Name</u>	<u>FIN Graphic On Tag</u>
PV Inverter	elec and equip and inverter and solar

3.4.5.2.3 Air Compressor

<u>FIN point name</u>	<u>Description</u>	<u>Facets</u>	<u>Interval</u>	<u>Units</u>	<u>Precision</u>
airComp1Ena	Air Compressor 1 Enable	ON, OFF	1HR, COV		
airComp1Sts	Air Compressor 1 Status	ON, OFF	1HR, COV		
airComp2Ena	Air Compressor 2 Enable	ON, OFF	1HR, COV		
airComp2Sts	Air Compressor 2 Status	ON, OFF	1HR, COV		
airDryer	Air Dryer Status		1HR, COV		
airPrs	Air Pressure		15 min	PSI	2
LEADSEL	Lead Compressor		1HR, COV		

<u>FIN Graphic Name</u>	<u>FIN Graphic On Tag</u>
SP Air Comp	compressor and equip and spAirCcomp

3.4.5.2.4 Geothermal Systems

3.4.5.2.5 Generators

Prefer to have ethernet cable run to Generators, with “Smart” Display.
Generator (Host Device) will follow Networking requirements.

3.4.5.2.6 ATS-E, and ATS-OS

<u>FIN point name</u>	<u>Description</u>	<u>Facets</u>	<u>Interval</u>	<u>Units</u>	<u>Precision</u>
atsNormPwrAvail	ATS Switch Normal Power Available	ON, OFF	1HR, COV		
atsSts	ATS Status	ON, OFF	1HR, COV		
freqEmerg	Emergency Frequency			Hz	
freqNormal	Normal Frequency			Hz	
PING					

- Include ATS points on Generator Graphic

- 3.4.5.2.7 CRAC Units
 - 3.4.5.2.8 Natural Gas Meter
 - 3.4.5.2.9 Electrical MDP and Sub Meters
 - 3.4.5.2.10 BTU Submeters
 - 3.4.5.2.11 Dom. Water Meter
 - 3.4.5.2.12 Dom. Hot Water
 - Dom. Hot Water Recirc. Pump
 - Dom. Hot Water Heater
 - Dom. Hot Water Heat Exchanger
- BAS to have direct integration of equipment.

<u>FIN point Name</u>	<u>Description</u>	<u>Facets</u>	<u>Interval</u>	<u>Units</u>	<u>Precision</u>
Alarm	Alarm	Conversion - or Normal, Alarm			
Pump Status			1HR, COV		
High Limit			1HR, COV		
HOA Status			1HR, COV		
Sensor Loss					
Setpoint			1HR, COV	°F	1
Temperature In			15 min	°F	1
Temperature Out			15 min	°F	1
Valve Command				V	1

- 3.4.5.2.13 Elevator Sump Pump
- 3.4.5.2.14 Radiant Floor Heating
- 3.4.5.2.15 Lab Exhaust
- 3.4.5.2.16 Cistern Level Monitoring
- 3.4.5.2.17 Vacuum Pump Monitoring
- 3.4.5.2.18 Lab Freezer Monitoring

(CX contract will include level of verification required. – Wake Tech D&C info only.)

3.4.6 FIN Global Scheduling

Global scheduling shall originate from FIN. Request Building/Equipment default weekly Schedule from Wake Tech Facilities Director through your Wake Tech PM.

- Primary/Replica Terminology
Primary schedules shall be written from FIN and pushed down to Replica schedules in field controllers and/or building supervisory controllers (JACEs, NAEs, IP Controllers).
- Event Schedules: Examples of what shall be programmed from FIN are; Sports Events and Special Events,
- Holiday Button

Holiday Button is used for Holidays or Campus Closures, to disable equipment on entire campuses quickly. Coordination with Wake Tech to include only non-critical equipment in the Holiday Button Program. Update O&M document at end of project. File located at;
**O&M app/User Manual/[Holiday Master Schedule: Equips Not Included in the Holiday Master Schedule](#)

3.4.7 FIN Historical Trending

For Reference, after integrated point is matched to FIN Point Library the Trending requirements per point will need to be added. New equipment and points will need historical trending discussion in CD phase to determine requirements.

Digital Trends

- enable the history,
- allow the hisCollectCov
- hisType: Collected

Analog Trends

- enable the history type
- hisType: Collected
- hisCollectInt: set for 15 minutes

3.4.7.1 History Totalization

Wake Tech intends to totalize energy consumption hourly, daily, monthly, and yearly. Marker Tags must be applied to energy points to allow 2 logic programs to run. (hisTotalizedRollover, hisTotalized)

3.4.8 FIN Alarm Logic

Wake Tech proposes a new way of thinking regarding BAS alarms. This goal will result in a reduced number of Alarms compared to traditional BAS installations for our service provider to respond to. The difference being, ONLY Critical Alarms/Logic will be programmed in FIN. Default alarms will be programmed and visualized in Skyspark. See [Section 3.5.2.1](#) for more information.

Elimination of nuisance BAS alarm notifications is a priority at Wake Tech.

Equipment and points will need alarm discussion in DD phase to determine requirements.

Wake Tech determines alarm types are based on hierarchy, as follows:

- | | |
|--|---|
| • Critical Alarms | See Section 3.4.8.1 for more information. |
| • Default Alarms | See Section 3.4.8.2 for more information. |
| • Device Status (Communication) Alarms | See Section 3.4.8.3 for more information. |

Our goal is for the EMIS to consistently notify our service and staff of alarms.

- Critical priority BAS Alarming and Loss of Communication alarms will be through FIN. (Enterprise BAS-UI).
- Default priority alarming will be through Skyspark (Analytics).
See Section 3.5.2 for further information.

See [Table 4.2 BACnet Alarm Level – Notification Table](#)

3.4.8.1 Critical Alarms

Wake Tech uses Table 4.2a (Critical Alarms Table) to determine what points per equipment will require Critical Alarm Logic.

Critical Alarm Logic will reside in the EMIS.

Marker “Tags” will be applied in FIN DB Builder to equipment and points for logic to run on. Complete list of Marker “Tags” can be found in Point Library Table.

Critical Alarms shall route to Alarm App and send out notification via email or text. Critical Notification Emails will use user account/property-Topics Email Immediate to send emails via Wake Tech Email Server to responsible recipients.

Some Critical Alarm Logic programs exist in FIN. (continuously evolving)

There are 2 alarm programs that shall be used for Boolean Alarm Points. These points may be integrated from HVAC DDC field controllers or from Third Party Devices.

- booleanAlarmsA1
 - Marker “Tags” included as example.
 - alarmPoint and allowProgram and boolA1 and (not reverseBoolean) and (not disableBoolAlarm)
- booleanAlarmsA2
 - Marker “Tags” included as example.
 - alarmPoint and allowProgram and boolA2 and (not reverseBoolean) and (not disableBoolAlarm)

Table 4.2a Critical Alarms Table

System Type	Alarm Type	Alarm Specifications	Delay (In/Out)	Priorty
Air Handling Unit	AHU Smoke Detector	Upon activation	None/None	A1
	AHU Heat Failure	Supply temp 5 degrees below discharge air heating setpoint	10 min. / 5 min.	A2
	AHU Fan Failure	Fan status does not match fan command	5 min./ 0 Min.	A1
	AHU Supply Fan Failure	Fan status does not match fan command	5 min./ 0 Min.	A1
	AHU Return Fan Failure	Fan status does not match fan command	5 min./ 0 Min.	A2
	AHU RA Smoke Detector	Upon activation	None/None	A1
	AHU Freezestat	Upon activation	None/None	A1
	AHU Supply Fan VFD Alarm	Upon activation	None/None	A2
	AHU Return Fan VFD Alarm	Upon activation	None/None	A2
	AHU Exhaust Fan VFD Alarm	Upon activation	None/None	A2
	AHU Condensate Level Shutdown	Upon activation	None/None	A2
Energy Recovery Unit	ERU Freezestat	Upon activation	None/None	A1
	ERU Return Smoke Detector	Upon activation	None/None	A1
Central Plant	Building CHWS High Temperature Alarm	Upon activation	None/None	A1
	Building HWS Lo Temperature	Upon activation	None/None	A1

	Alarm			
	CHWP Failure with Single Secondary Pump	Pump status does not match pump command	5 min./ 0 Min.	A1
	CHWP Failure with multiple secondary pumps		5 min./ 0 Min.	A2
	CHWP VFD Alarm	Upon activation	None/None	A2
	HWP Failure with Single Secondary Pump	Pump status does not match pump command	5 min./ 0 Min.	A1
	HWP Failure with multiple secondary pumps		5 min./ 0 Min.	A2
	HWP VFD Alarm	Upon activation	None/None	A2
	Chiller Failure Alarm Signal	Upon activation	None/None	A1
	Boiler Failure Alarm Signal	Upon activation	None/None	A1
	Refrigerant Monitor Alarming	Upon activation	None/None	A1
Generator	Generator Alarm Signal	Upon activation	None/None	A1
	Generator Running	Upon activation	None/None	A1
	Generator Leak Detection Alarm Signal	Upon activation	None/None	A1
	Generator Low Fuel	Upon activation	None/None	A1
	Generator Tank Rupture	Upon activation	None/None	A1
Kitchen Exhaust/Make-Up Air Unit	Exhaust Fan Fire Alert	Upon activation	None/None	A1
	Exhaust Fan High Temp Shutdown	Upon activation	None/None	A1
	Exhaust Fan Kill Switch	Upon activation	None/None	A2
	MAU Smoke Detector Status	Upon activation	None/None	A1
	MAU Emergency Shutdown	Upon activation	None/None	A1
	MAU Freezestat Status	Upon activation	None/None	A1
	MAU Heating Failure	Supply temp 5 degrees below discharge air heating setpoint	10 min. /5 min.	A2
	MAU OAD Failure	Damper status does not match damper command	5 min./ 0 Min.	A2
	MAU Supply Fan Failure	Fan status does not match fan command	5 min./ 0 Min.	A2
Fire/Security	Security System Panel Alarm Signal	Upon activation	None/None	A2
	Fire Alarm System Panel General Alarm Signal	Upon activation	None/None	A1
Miscellaneous	UPS Alarm Signal (if applicable)	Upon activation	None/None	A1
	Elevator Sump Alarm signal (if applicable)	Upon activation	None/None	A1
	Elevator Equipment Room Hi Temp Alarm	Upon activation	None/None	A2
	Freezer Status Alarm	Upon activation	None/None	A1
	Refrigerator Status Alarm	Upon activation	None/None	A1
Packaged DX Rooftop Unit	IT-MDF Room High Temp	Upon activation	None/None	A1
	UPS Room High Temp	Upon activation	None/None	A1
	Unit Failure Alarm	Upon activation	None/None	A1
	Gas Heat Failure	Supply temp 5 degrees below discharge air	10 min. / 5	A1

		heating setpoint	min.	
Lift Station	Lift Station Power Failure	Upon activation	None/None	A1
	Lift Station Float Switch/Level Alarm	Upon activation	None/None	A1
	Lift Station Pump Failure	Pump status does not match pump command	5 min./ 0 Min.	A1
Lab Exhaust Systems	Isolation Damper Alarm	Upon activation	5 min.	A1
	Exhaust Fan Alarm	Upon activation	5 min.	A1
	Exhaust DP Alarm	Upon activation	5 min.	A1

3.4.8.2 Default Alarms

Wake Tech prefers to not include default alarms on FIN. Instead Wake Tech prefers to have rules in Analytical software to cover default alarm problems that will be shown in Sparks, KPI, and Equipment Score Dashboard Apps.

See [Section 3.5.2](#) Analytics/Apps for more information.

3.4.8.3 Device Status Alarms

For reference, two alarm programs are used to report if a Building Level Field Controller is Online and communicating or Offline and not communicating.

- Device Status Alarm
- Device Status IP Alarm

Alarms will route to Alarm App. Based on the priority of the Device Status Alarm, notifications will use Topics Email Digest send emails to responsible parties.

3.4.8.4 Notifications will be provided by FIN.

Wake Tech uses two types of Topics to provide notifications: Topics Email Digest, and Topics Email Immediate.

Topics are based on BACnet Alarm Levels.

In order for alarm notifications to be sent to the correct email recipients, the Designer and Contractor shall use BACnet alarm levels shown in the BACnet Alarm Level – Notification Table below.

Table 4.2 BACnet Alarm Level – Notification Table

BACnet Alarm Level	Wake Tech Alarm Priority	Notification
10	A1	Email sent to Wake Tech & MCSP. Call center notified.
15	A1 & IT	Email sent Wake Tech, MCSP. Call Center & IT notified.
20	A2	Email sent to Wake Tech & MCSP.
30	Default	No notification. Alarm is logged and sent via daily digest.

- (BACnet Alarm Levels 10)
 - Immediate notifications sent to
 1. Wake Tech Facility Managers – 24/7
 2. MCSP technicians – 24/7
 3. On Call Center - M-F from 4pm to 7am. 24/7 weekends and holidays.
- (BACnet Alarm Levels 15)
 1. Wake Tech Facility Managers – 24/7
 2. MCSP technicians – 24/7

3. Wake Tech IT Staff – 24/7
 4. On Call Center - M-F from 4pm to 7am. 24/7 weekends and holidays.
- (BACnet Alarm Levels 20)
 1. Wake Tech Facility Managers – 24/7
 2. MCSP technicians – 24/7
 - (BACnet Alarm Levels 30)
 - No immediate notifications sent; these alarms shall be included in FIN Daily Digest Notification.
 - Notifications shall be routed through Wake Tech internal email account. Maintained by Wake Tech IT Dept.
The Email Recipients list shall be maintained in FIN.
 - Wake Tech Facilities Managers
 - MCSP technicians
 - Wake Tech IT Staff
 - On Call Center.
 - Alarm Classification/Priority
Refer to [Table 4.2a-Critical Alarms](#) of this Guideline.
 - Alarm Notifications
Refer to the [Table 4.2 BACnet Alarm Level – Notification Table](#) in this Guideline for notification categories.

3.4.9 FIN Graphic Builder

The Master System Integrator (MSI) will define and create fully developed graphics for the end user to operate, troubleshoot and maintain BAS controlled equipment.

Equipment templates available within FIN – Wake Tech project.

Thumbnail images shall be used on Related Graphics. Wake Tech has a library of thumbnails saved. For consistency use existing thumbnail images.

Named thumbnail (equipment).png

3.4.9.1 RGB Color Codes.

For consistency across BAS Enterprise Graphics, Wake Tech prefers to use these RGB codes on Water piping.

- Chilled Water - **Blue**
 - Supply 004fb0
 - Return 92aed1
- Makeup Water – **Green**
 - Supply 00b006
- Domestic Hot Water – **Red**
 - Supply b00000
 - Return d19292
- Geothermal Water/Condenser Water - **Gray**
 - Supply F1F3F4
 - Return 7D8286
- Heating Hot Water - Red
 - Supply b00000
 - Return d19292

3.4.10 FIN Summary Builder

Wake Tech currently includes these Summaries to quickly view equipment data.

- Top Level AHU, CHW, HWS
 - Add points included.
- Campus Level AHU, CHW, HWS
 - Add points included.
- Site Level AHU, CHW, HWS, FCU, TU, DMSS (Split System)
 - Add points included.

3.4.11 FIN O&M Documents

Controls As built and Mechanical As built Drawings shall be loaded onto the Enterprise Server and be available through FIN End User App.

3.4.12 FIN Backups

Enterprise BAS backup programming exists, data is automatically saved to the Server C drive.

3.4.13 Renovations

If working on a Site that is under a Wake Tech D&C renovation project, please add “Tags” to “isolate” that part of the Site from the rest of the FIN Project. Please use the “underConst” Tag on any of the following Site, Floor, or Equipment. By doing so, end users should not be able to view or receive alarms until project is ready to be turned over and “Tags” removed. Please remove all “Tags” 2 weeks prior to BAS owner training. (Project MSI-milestone)

To ensure Alarms are notifying Construction Team only (CG, CX, ME Contractor, Wake Tech PM, Wake Tech BAS Control & CX Engineers, and BAS Contractor), create a specific Topic. (Name specific enough to reference project)

3.5 Other EMIS Applications

3.5.1 Overview

After the construction phase of the project is completed, the newly integrated Building point data will be integrated into two other EMIS applications.

- Skyspark will use integrated point data for Historical Data, Analytic Rules, Sparks, KPI Views, and EUI Dashboard Views.
- Dashboard, application TBD in future, will present Building Data on Marketing displays at building entrances.

3.5.2 Analytics

Wake Tech has licensed and maintains an Enterprise Analytics application to run Fault Detection and Diagnostics (FDD). Similar to FIN, Analytic host capacity -Point License will be evaluated on every project to ensure coverage for new points integration.

Wake Tech analytics platform is SkySpark developed by SkyFoundry. SkySpark can be configured to:

- Identify HVAC system-level and equipment-level Sparks that if mitigated, can save energy, reduce demand, and/or improve occupant comfort and health,
- Provide early identification of faults to extend equipment life, and
- Visualize and provide regular reports to managers, technicians, and other personnel on building performance.

3.5.2.1 Apps

Below is a list of Apps developed on Skyspark platform.

- Arc

- Builder
- Capturis
- Code
 - Project DD design Wake Tech, Commissioning, and MEP Engineers shall determine if future development of Spark/KPI Rules are needed to provide performance information (Sparks) on equipment.
 - # of Rules (and Kind) to be added to Skyspark shall be included in Div. 25 spec.
 - Rules will take the place of Default BAS Alarming.
 - Rules not in place as determined during DD phase, shall be developed by the MSI to allow for visualization of equipment poor performance.
 - Shown on Sparks, KPI, and Equipment Score Dashboard apps.
- Dashboard
 - Project DD design Wake Tech, Commissioning, and MEP Engineers shall determine if future development of Dashboards will be needed.
- Energy
- FIN Connectors
- Favorites
- GhG
- Health Status
- Historian
 - Event Extension.
 - New View or Custom App. The view and the custom app can be formulated during the design development.
- KPI
- Periscope
- Rule
- Spark
 - Low CHWS/HWS DP
- Task
- Tools
 - Job
 - MSI will inform Wake Tech BAS Engineer that they are ready to import building point data by an existing import Job (import site). Based on Tagging/Point Names and point info will automatically populate into other apps and views.
 - After running Job to import new site, these further steps will be required.
 - Verification of point Histories.
 - Sparks/KPI's views are populating for new site
 - Equipment Score Dashboard. Ensure new site populates.
 - Include new site name in Wake Tech Building List.csv. based off Capturis Bldg. name.
 - Coordinate with Wake Tech EST Dept to get Capturis Names.
 - Wake Tech EST Dept. does monthly upload of Capturis data. MSI to coordinate work with one of these uploads to ensure sites populate on view.
 - Baseline data to be added to testBaselineData.csv.
 - Coordinate with Wake Tech EST Dept to get designers baseline data.
 - A site must be listed in this .csv with it's monthly EUI for the baseline date in the EUI Details view to be displayed.
 - Descriptions added to estimateDescriptions.csv.
 - Descriptions required for view to populate.

- MSI to include new site name in site selector of Capturis and EUI views.
- Views/Reports
 - Project DD design Wake Tech, Commissioning, and MEP Engineers shall determine if future development of Views/Reports is needed by Energy Leadership.

Consistency

Every MSI shall use same FIN navigation structure in Skyspark. le-Campus/Site/Floor/Equip.
 All work not consistent will be redone at no expense to college.

3.5.3 Calculations

C.O.P (Coefficient of Performance)

Incorporate the following into sequence of operation:

Provide energy reports for monitoring and display by the EMIS (Skyspark) via the following COP calculation.

Calculation outlined is to be incorporated into existing campus COP calculation.

Energy output measured from BTU meters and energy input measured from power meters.

BACnet points are to be captured at an hourly rate.

Provide quarterly report of HW and CHW plant equipment.

Create and Add to COP Dashboard.

Calculations for plant COP shall utilize measurements from the following:

- Equipment below in blue was specific to project specification was copied from.

Energy output,

labeled as "Hot Water Production (million Btu/hr) + Chilled Water Production (million Btu/hr)",
 to be measured by adding the following values.

Provide necessary conversions from measured kW to BTUH:

"Chilled Water Production" = BTU meter via [FM-CHWR-01](#), [TS-CHWS-01](#) and [TS43 CHWR-01](#).

"Hot Water Production" = BTU meters via [FM-HWR-01](#), [TS-HWS-01](#) and [TS-HWR-01](#).

Energy input,

labeled as "Utility Consumption (million Btu/hr)",
 to be measured by adding the following values.

Provide necessary conversions from measured kW to BTUH:

"Heat Pump Energy Input" = Sum of the power consumption of heat pumps [CH-1](#), [CH-2](#), and [CH-3](#). Power consumption available on each heat pump via controller BACnet points.

"Pump Energy Input" = Sum of power consumption of pumps [PALP-1A & 1B](#), [PCHWP-1A & 1B](#), [PHWP-1A & 1B](#), [PCHWP-2 & 3](#), [PHWP-2 & 3](#), [SHWP-1, 2, & 3](#), [SCHWP-1, 2, & 3](#), and [SGWP-1, 2, & 3](#).

Power consumption available on each pump via VFD BACnet points.

"Utility Consumption" = [Heat Pump Energy Input + Pump Energy Input]

Coefficient of Performance (COP):

[Hot Water Production (million Btu/hr) + Chilled Water Production (million Btu/hr)] ÷ Utility Consumption (million Btu/hr)

Year-To-Date Coefficient of Performance

[Year-to-Date Hot Water Production (million Btu) + Year-to-Date Chilled Water Production (million Btu)] ÷ Year-to-Date Utility Consumption (million Btu)

Monthly Coefficient of Performance

[Monthly Hot Water Production (million Btu) + Monthly Chilled Water Production (million Btu)] ÷ Monthly Utility Consumption (million Btu)

Weekly Coefficient of Performance

[Weekly Hot Water Production (million Btu) + Weekly Chilled Water Production (million Btu)] ÷ Weekly Utility Consumption (million Btu)

3.5.4 Dashboard

The College has also licensed Periscope, developed by Building Controls & Solutions. Wake Tech is evaluating Periscope capability to serve as its energy, water, and transportation dashboard. Wake Tech is also evaluating FIN and Skyspark Dashboard capabilities.

Dashboard software is an advanced Energy Information System that allows non-facilities stakeholders to monitor and raise awareness of sustainability metrics at Wake Tech. Campus, building or transportation specific dashboards can be comprised of one or more viewlets that track consumption, demand or other metrics related to energy, water, and transportation. An important feature of dashboards is to represent consumption or demand metrics in the form of equivalencies. For example, energy reductions can be represented in the form of reduced carbon emissions, or the number of trees planted.

The college has not decided yet on the Dashboard software. Plans to develop in future TBD.

4. Building or Site – Field (DDC) Controllers

4.1 Overview

At the Building level, the Building's BAS system shall be comprised of BACnet IP/MSTP type compliant equipment controllers. In the event of a communications failure from the EMIS, the Building level BAS shall be capable of operating in a standalone mode. Every Building BAS shall be connected to the Enterprise Level BAS. All devices shall be UL listed, FCC approved, and BACnet Compliant.

Beginning in 2021, Wake Tech eliminated building supervisory controllers from BAS Network Architecture on Capital and Renovation Projects. Supervisory Devices may be employed in renovation projects to upgrade existing (out of date) supervisory devices. Consult with Wake Tech PM and Wake Tech BAS Controls Engineer during DD/CD phase to determine requirement. If included in design refer to Section 4.6 for further guidance.

At the building level, BACnet building controllers (B-BC) that do not require software licensing shall be used with high level field controllers such as BACnet advanced application controllers (B-AAC) and lower level BACnet application specific controllers (B-ASC) to perform BAS functions. The designer and contractor shall provide enough B-BC, B-AAC and B-ASC capacity, both in number of controllers and computing power, to perform BAS functions in the project.

4.1.1 BAS Contractor Scope of Work

BAS contractors shall install, program, I/O checkout, and complete pre-functional CX checklist for all building level controllers per project contract and ensure network connectivity is coordinated for MSI. BAS Contractor will support CX Agent during Functional Testing.

Prior to Controls submittal and or programming of controllers, the BAS Controls contractor shall request a meeting with Wake Tech. At this meeting, Wake Tech will discuss the following information:

- a) Point Library Schematic and Point Library Table,
- b) Wake Tech TC/IT Network Requirements,
- c) A defined range of BACnet device ID numbers to use on the project.
- d) MSI coordination.

4.1.2 Product Installation Requirements

Installation of the system shall be by qualified employees of the BAS controls manufacturer, or its exclusive authorized representative, or qualified subcontractor. Direct supervision of BAS work being performed by non-qualified contractors is required.

The installation contractor shall provide all tools, testing and calibration equipment necessary to ensure reliability and accuracy of the control system.

All equipment, components, hardware, software, and ancillary devices shall be new and fully warranted for material and labor as required by the state of North Carolina and Wake Tech procurement requirements. In no event shall product or service warranties be less than 1 year from acceptance of the project the Wake Tech project manager.

4.1.2.1 DDC Software

BAS Contractor shall load all attendant software required to remotely support, troubleshoot and backup the building level BAS on BAS server(s) at Wake Tech (e.g., Distech package files, JCI FX package files) to maintain and remotely support all BAS components.

Authority to specify these systems has been granted under the College Construction Delegation Authority. Justification: Software is currently in use by the college and is open to multiple vendors to install and service.

Approved field controller software is listed below:

Distech – EC-GFX

Facility Explorer (FX) - CCT

4.1.2.2 Communication

4.1.2.2.1 Local Ethernet Port

The local Ethernet port of the BAS field panel or controller shall be capable of supporting network speeds no lower than the 10/100Base-T standard. If faster communications are required to interface with the enterprise BAS through the Wake Tech IT network, Contractor is responsible for installing such devices.

4.1.2.2.2 BAS Data Updates

The BAS system must be capable of updating a COV from any point on the system across the network to the Wake Tech BAS Enterprise server with less than 10 seconds of latency at all times.

4.1.2.2.3 BACnet IP

The building level BAS must include the ability to perform all AST-functions via BACnet IP or BACnet MSTP.

Once the BAS is integrated to the EMIS Server, the BAS Contractor shall participate in performance testing and tuning BAS components. Potential issues include, but are not limited to, response time (or time-outs) on AST functions, polling intervals, or field controller processor and memory performance.

All upstream communication to the enterprise server shall be via BACnet IP, or, if required to prevent overloading the IT network infrastructure, a more efficient communication protocol (e.g., TCP/IP).

4.2 DDC Controls

4.2.1 General

The controls contractor shall be responsible for all new controllers, control devices, control panels and enclosures, controller programming, controller programming software, controller input/output and power wiring and controller network wiring. The controls contractor shall also be responsible for execution of EMIS scheduling on field controllers. (Writing to replica schedules on field controllers, or writing directly to command points)

4.2.2 Wiring Identification

4.2.2.1 Communication

BAS Host Device communication (CAT) cable labeling.

- Jacket Color Blue
- Jacket identified as BAS every 3'. (This is an option from distributors like Windy City Wire)
- Label ends with Switch # & Port #. (Provided by BAS contractor, Label maker tape ok.)

4.2.2.2 Control Wiring

Wake Tech prefers the Start or Enable wire to be hardwired and not passed via network.

Important for third party equipment.

Only exception is for CHWS/HWS DP. These points can be passed via network to Plant when distance is cost prohibitive.

Identify with nonconducting "tag" attached to each end. (Label maker = OK)

Designate by the point name.

e.g., DA-T, or CHW-VLV-O

4.2.2.3 Network Switches

Wake Tech IT will provide one network drop for BAS. BAS Contractor to design network architecture to ensure coverage per distance limitations.

4.2.3 Controller I/O count

BAS submittal shall include extra points per controller to ensure coverage for point failure or future expansion. Each controller shall have at least 2 extra Inputs and 2 extra Outputs, or 10% spare, whichever number is greater.

4.2.4 TU Controller Power

Use of Multichannel Transformer banks supplied by BAS contractor is preferred method to power all TU controllers.

All line voltage circuits supplying transformers shall be fed from generator back-up power.

Transformer panels shall be easily accessible, ME rooms, above corridor ceilings.

Controls submittal shall include a Terminal Unit Schedule.

Schedule shall include transformer name and channel number for each TU.

Desired coordination of controller power circuit with communication Port on Network Switch.

4.2.5 Programming

Graphical Programming shall be provided with printed narratives and/or flow diagrams to document algorithms and how to modify and use them. The engineering tool shall be capable of accessing the controller directly from a portable (laptop) PC and accessing a controller through the IT network from a server maintained by Wake Tech.

4.2.5.1 Alarms

Div. 23 will program alarming logic in building level DDC controller with result writing to a Boolean point, named *pointNameAlarm*. Alarm logic shall include time delays and other logic to prevent nuisance tripping. Facets shall be programmed (True = Alarm. False = Normal). Refer to Section 3.4.9.

4.2.6 Sensors and Input Hardware

The following devices shall be provided in accordance with Division 23 requirements. The designer / engineer shall ensure that BAS functionality meets the College's expectations and project requirements for each project.

1. Field-Installed Temperature Sensors
2. Field-Installed Humidity Sensors
3. Field-Installed CO2 Sensors-shall be ABC type. Automatic Background Calibration.
4. Transmitters
5. Current Transducers – (preferred method of verifying status on Fans and Pumps.
6. Pneumatic and Electric Transducers
7. Air Quality Sensors (Bi-Polar)

8. Input Switches
9. Freeze Protection Thermostats – shall have manual resets. Alarm BAS.
10. Air Flow Measurement Stations (Ebtron with EB-Link)
11. Energy Metering
12. Refrigerant Leak detectors

4.2.7 Output Hardware

1. Control Dampers
2. Control Valves
3. Actuators
4. Output Signal Conversion
5. Output Switches

4.2.8 Override at Field Controller

B-BC and B-AAC field controllers must allow override of writeable points directly at a local controller display.

4.2.9 Electrical High/Low Voltage Distribution

1. Transformers
2. Surge and Transient Protection
3. Wiring
4. UPS and Battery back-up power

4.2.10 Pneumatic Power, Supply and Tubing

1. Air Compressors
2. Refrigerated Air Dryers
3. Compressed Air Discharge Filters
4. Air Pressure Reducing Stations
5. In-line Filters
6. Pneumatic Tubing

4.2.11 Data Requirements

Refer to the Wake Tech Point Library and Point Library Table for BAS data requirements.

4.2.12 BACnet Instance Numbers (BACnet ID)

There must be no duplication of BACnet Device ID's. Contractors shall obtain a range of BACnet device IDs for use on each project from the BAS Controls Engineer.

4.2.13 BACnet point passing.

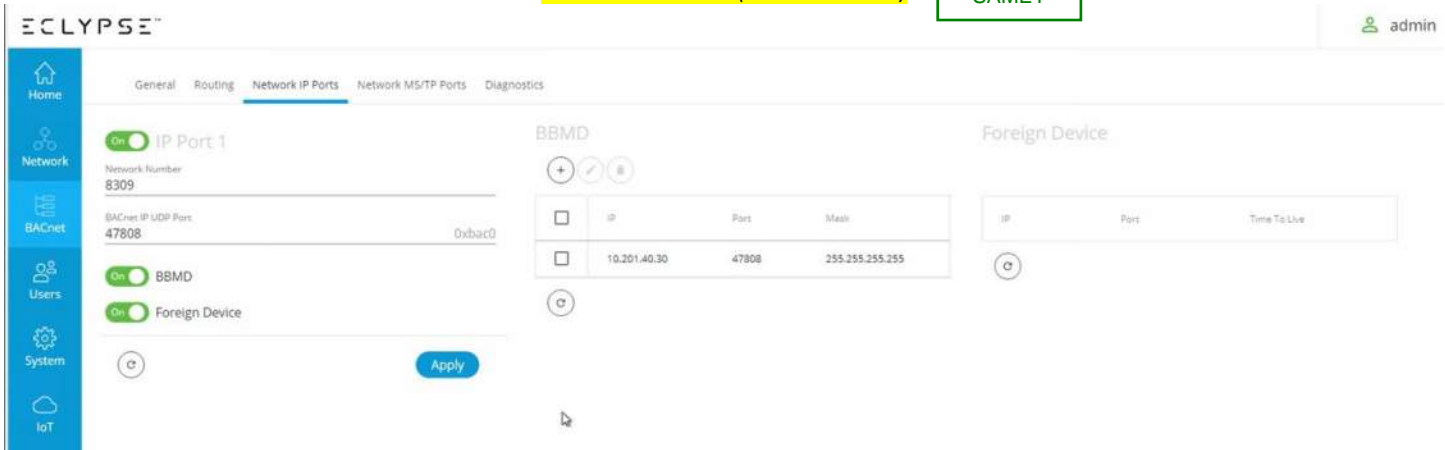
Passing BACnet point data across VLANS.

Each VLAN requires a BBMD.

Make AHU-1 controller the BBMD.

Ie. AHU-1 controller in bldg. A is BBMD, and AHU-1 controller in bldg. B is BBMD.

Photo for reference only.



4.3 DDC Software Backups

4.3.1 Overview

Prior to project acceptance by the Wake Tech project manager, a backup file of all DDC field controllers shall be created and turned over to Wake Tech. This file shall be generated by upload and contains programming for each field controller as it exists on the date of project acceptance.

4.4 Execution/Workmanship

4.4.1 Enclosures

Control equipment panels shall be designed, fabricated, and installed in accordance with the codes and standards referenced in this Standard, the project specific requirements (Division 23), and the following:

- a) Enclosures shall facilitate the mounting of gauges, switches, pilot lights, and the like, on the face panel when required. Control devices that are mounted on the face of the panel (e.g., meters) shall be identified with engraved nameplates.
 - i. Panels shall be UL508A compliant.
- b) All wiring in panels shall be labeled at termination points.
- c) Power Transformers: Step-down power transformers shall be provided for all DDC controllers and associated accessory devices as required. Transformers shall be sized and selected to accommodate all connected accessory items. Transformers shall be UL Listed Class 2 type with 120 VAC primary, 24 VAC or VDC secondary.
- d) Controls wiring: All wiring shall be installed in a neat and professional manner. Control wiring shall not be installed in power circuit conduits or raceways.
 - i. All wiring concealed above ceilings shall be plenum rated cable.
 - ii. All wiring in Mechanical Rooms, Electrical Rooms shall be run inside EMT conduits.
 - iii. Exterior cables will be run in EMT or flexible conduit.
- e) All Control Panel doors shall include a lock for security.

4.5 Temperature Declaration

4.5.1 Local Tstat Adjustment

Wake Tech Temperature **Occupied** Set Points

rev. 2022-09-06

	Admin, Office, Conference & Break Room	Classroom, Library & Testing Center	Warehouse & Storage	Facilities & Shops	Industrial Labs	Culinary Labs	Science Labs	Healthcare Labs	Computer Labs	Robotics, 3-D Printer Labs	Common Areas, Hallways & Restrooms	Mech & Elect Rooms	MDF / IDF	Gymnasium, Weight Room, Convention & Auditorium	Specialized Spaces
Summer High	74	74	77	76	75	74	74	68	73	72	74	79*	76	73	**
Set Point	73	73	76	75	74	73	73	67	72	71	73	78*	75	72	**
Summer Low	72	72	75	74	73	72	72	66	71	70	72	77*	74	71	**
Winter High	71	71	67	68	69	71	71	66	70	71	71	56*	n/a	70	**
Set Point	70	70	66	67	68	70	70	65	69	70	70	55*	n/a	69	**
Winter Low	69	69	65	66	67	69	69	64	68	69	69	54*	n/a	68	**

Wake Tech Temperature **Standby** Set Points

	Admin, Office, Conference & Break Room	Classroom, Library & Testing Center	Warehouse & Storage	Facilities & Shops	Industrial Labs	Culinary Labs	Science Labs	Healthcare Labs	Computer Labs	Robotics, 3-D Printer Labs	Common Areas, Hallways & Restrooms	Mech & Elect Rooms	MDF / IDF	Gymnasium, Weight Room, Convention & Auditorium	Specialized Spaces
Summer High	77	77	80	79	78		75	71	76	74	74	n/a	n/a	76	**
Set Point	76	76	79	78	77	74	74	70	75	73	73	n/a	n/a	75	**
Summer Low	75	75	78	77	76		73	69	74	72	72	n/a	n/a	74	**
Winter High	68	68	64	65	66		68	64	68	69	71	n/a	n/a	67	**
Set Point	67	67	63	64	65	67	67	63	67	68	70	n/a	n/a	66	**
Winter Low	66	66	62	63	64		66	62	66	67	69	n/a	n/a	65	**

Wake Tech Temperature **Unoccupied** Set Points

	Admin, Office, Conference & Break Room	Classroom, Library & Testing Center	Warehouse & Storage	Facilities & Shops	Industrial Labs	Culinary Labs	Science Labs	Healthcare Labs	Computer Labs	Robotics, 3-D Printer Labs	Common Areas, Hallways & Restrooms	Mech & Elect Rooms	MDF / IDF	Gymnasium, Weight Room, Convention & Auditorium	Specialized Spaces
Set Point	80	80	84	83	82	75	80	76	80	79	81	84	75	80	**
Set Point	62	62	58	59	60	60	60	55	60	62	62	55	n/a	61	**

Definitions:

Occupied	Normal hours of operation, based off building schedules
Standby	Mode that is activated when an occupied space is vacated for a set period of time (as programmed into the sequence of operation), as determined by space sensor(s)
Unoccupied	Afterhours of operation, based off building schedules, which includes overnight, weekends, holidays, and closed days

Notes:

*78 when cooling is provided. If cooling is not provided, space should be ventilated per code.
 **Specialized areas require input from user group and approval from Facilities Directors
 Stairwells may not be heated or cooled

Occupants shall have limited ability to locally adjust their zone Set Point +/-1 degree from Occupied Set points. This along with Occupied Temp Setpoint provides the occupant(s) a 5 degrees dead band. BAS controller shall include a Boolean point, (zone remote setpoint enable) to Allow "Full Access" or "No Access".

Default being No Access.

Include Occupied Dehumidification Setpoints for individual zones.

Include Unoccupied Dehumidification Setpoints, compare zones to an average.

4.6 Building Supervisory Controllers

4.6.1 Overview

Beginning in 2021, Wake Tech no longer allows use of building supervisory controllers that require ongoing software licensing fees (service maintenance agreements) for BAS.

For D&C Renovation projects in buildings that have legacy BAS systems that include Building Supervisory Controllers, discussions in DD phase will need to occur to determine if new equipment/points and logic can be added to existing controllers.

The following network controller may be used, if discussed with Wake Tech BAS Controls Engineer during DD Phase.

- Tridium JACE
 - For BAS with JCI field controllers, an FX JACEs shall be used.

4.7 Utility Metering

4.7.1 Overview

Wake Tech operates facilities to maintain or improve occupant health and comfort, and to practically minimize utility and energy consumption. In order to manage utilities and related building operations as part of any comprehensive utility management program, facilities personnel require timely utility data at the building level. Toward this end, Wake Tech intends to continuously monitor its utilities through the Building Automation System (BAS) and Energy Management and Information Systems (EMIS). The continuous monitoring system outlined in this Metering Standard is designed to provide accessible, accurate and consistent performance metrics to inform the maintenance and operations stakeholders regarding the performance of campus buildings. Service categories to be monitored are:

- Electric Power
- Domestic Water
- Natural Gas
- Propane
- Chilled Water
- Heating Hot Water
- HVAC Makeup Water

This Metering section provides a description of the devices and techniques that will be used to measure energy and water performance and outlines implementation measures, such as the methods for measuring, storing, and reporting building utility usage. This Metering section is intended for meter selection and data integration for use by designers, contractors, Wake Tech personnel and other parties working on facilities in the Wake Tech building fleet.

4.7.2 Goals

Wake Tech's goal is to define the framework for real-time and on-going measurement and storage of Wake Tech's energy and utilities consumption data to evaluate building efficiencies. Wake Tech desires to document and understand the utility performance of its buildings in order to develop strategies to help minimize energy and water consumption and to discover and investigate operations and maintenance issues. This Metering section addresses the provisions necessary to accurately measure and monitor the utilities serving campus buildings in a consistent manner.

The EMIS will be used to collect, store, and display the data defined by this Metering section via the Enterprise BAS, Analytics, and Dashboarding software. Building sub-meters shall utilize the communications protocols identified in this section to communicate with the Enterprise BAS. Currently, several meters communicate through Niagara JACEs and can be viewed in the Niagara Framework; any metering data present in the Niagara Framework should be present in the Enterprise BAS as well.

The primary goals are to:

- Identify acceptable measurement devices for building utility usage and summarize installation requirements as they apply to Wake Tech.
- Define acceptable communications protocols utilized for connection of the meters to the BAS and Dashboard systems.
- Define the data to be measured and stored for each metering device.
- Establish a consistent approach for data collection, storage, and use in the Enterprise BAS and EMIS employed by Wake Tech.

4.7.3 Measured Values

Required measured values are listed in Appendix A, an excerpt from the Wake Tech Point Library Table. The excerpt details points that must be provided to the Enterprise BAS by each type of meter as well as the BAS database requirements, including point naming, tagging, units of measure, graphic status, etc. If a meter provides points other than those specified in Appendix A, they should be added to the Enterprise BAS according to the full Wake Tech Point Library Table, or the naming and tagging conventions aligned with it. Each measured value in Appendix A shall be available at the Enterprise BAS as both a live and historical value.

Meters will capture usage data 24 hours a day and 7 days a week. Data shall be stored locally in accordance with OEM specifications.

Live measured values shall be displayed in Enterprise BAS as well as future Dashboards. Historical data shall be displayed in charts and reports via the Analytics platform; it shall also be accessible in the Enterprise BAS. Historical data can be added to graphics in the Enterprise BAS as well as future Dashboards as deemed appropriate.

Data trending requirements:

Meter consumption data shall not be set up to rollover or reset to zero at any point. This only applies to consumption values that are totalized in nature such as electrical consumption (kWh), CHW & HHW BTU consumption, water consumption (gal), and gas consumption (cf). Instead, the monthly/daily/hourly data can be viewed in a “delta” format, whereby the difference or change in a consumption value from one timestamp to the next is calculated. Delta histories are preferred if the meter has an inherent register rollover value because they are more fault tolerant for long term data collection.

1. These calculations shall be performed and viewed in SkySpark.
2. If future Dashboards require delta histories to be represented as a point, the calculations shall be performed a) in the JACE through which the associated meter is integrated, or b) in the Enterprise BAS software if the meter is not integrated through a JACE.
3. Unless otherwise noted, all specified measured values shall be captured in 15-minute increments at Enterprise BAS.
4. Meter interval data shall be captured with a timestamp ending with :00, :15, :30, and :45 for every hour of data recorded for consistency with utility billing. For example, a trend shall be captured at 1:00, 1:15, 1:30, 1:45, and 2:00 pm, etc.

Monthly Utility Bill Data:

- Wake Tech utilizes Capturis to track their monthly utility use and cost for electric, gas and water accounts. Monthly utility billing determinants and values are manually imported to the EMIS via SkySpark.
- All available monthly utility bill data (dates, consumption, account number, and cost) shall be imported to SkySpark on the fifth of each month.

4.7.4 Communications

A. Meter Communication Requirements

Meters shall have the ability to communicate to the Enterprise BAS via at least one of the following protocols:

Serial & Ethernet Communications:

- a. BACnet IP
- b. BACnet MS/TP

Analog & Digital Output (with Gateway):

- a. 4-20 mA
- b. 0-10 VDC
- c. Scaled pulse.

All metering devices are to be connected to the existing secured data network. Wake Tech provides the BACnet Device ID # and network, and the IP Address will be set DHCP if possible. If the device cannot be set for DHCP then a static address will be provided. The following information must be provided to the Wake Tech BAS Controls Engineer via the Wake Tech Project Manager in an excel spreadsheet to add devices to the Wake Tech network:

- 1. Total count of host devices
- 2. Locations of host devices
- 3. Device Name
- 4. Device MAC

Meters and enclosures shall be suitable and rated for the installed environmental conditions.

B. Data Acquisition Device (JACE) Requirements

- i. There are several Niagara JACEs currently in use at Wake Tech with connected metering devices. All metering data shall be integrated into the Enterprise BAS. If the JACE is planned to integrate meter data and pass to the Enterprise BAS, a pre-construction meeting will be required to verify the JACE License has availability to include the Device/Points.
- ii. The JACE shall collect all the required meter measured values listed in Appendix A. The data shall be available as a live point value both in the JACE and the Enterprise BAS, and the data shall be trended in the Enterprise BAS.
- iii. If a project causes a JACE or its data to be replaced or renamed in the BAS architecture, the contractor of record shall be responsible for restoring any broken links to the EMIS.

C. Network Accessibility

- i. Network access is to be coordinated with Wake Tech BAS Controls Engineer through the Wake Tech Project Manager.

4.7.5 Meters, Hardware, & Installations

A. General

- i. All metering equipment shall have a minimum of a 1-year warranty. Refer to specific utility function and meter for more strict warranties.
- ii. All device installations (meters and gateways) shall have a minimum parts and labor warranty of 1 year to account for any inconsistencies or discrepancies with this Standard.
- iii. Power, where needed, shall be obtained from a dedicated 20 Amp circuit in the nearest local building electrical panel unless otherwise stated. The electrical panel schedule shall be updated in the field. The Panel/Circuit information is to be included in the Controls As Built and Record Control Drawings.
- iv. Acceptable meter models and manufacturers are listed in this section and summarized in Appendix B.

B. Installation

- i. The meter shall be installed to manufacturers' guidelines and any questions regarding the installation shall be referred to the local meter representative for confirmation prior to installation.
- ii. All meters shall be installed in an easily accessible location that allows for direct and easy reading of a visual display and convenient calibration and maintenance provided the installation follows all OEM installation guidelines.
- iii. Bypass piping and valving shall be included in the design of all water and natural gas meters, to allow servicing of inline meters without disruption of service. All heating hot water (HHW) and chilled water (CHW) metering devices, including BTU meters, flow meters and temperature sensors, shall be specified to be serviceable without requiring shutdown of associated HHW and CHW systems. Manufacturers required straight run piping must be provided upstream and downstream of all metering devices.

C. Ethernet Gateway

- i. If a meter does not have an integrated backlit display, or if it does not have BACnet IP capabilities, it shall communicate through an ethernet gateway device.
- ii. The preferred gateway device is the Onicon D-100 Flow Meter Display.

D. Electric Power Metering

i. General

1. One or more electric sub-meters shall be installed to capture total building electricity data. Multiple sub-meters may be required for specific areas of a building or for specific equipment loads such as HVAC, lighting, etc.
2. Electric Power meter shall measure at minimum the values in Appendix A associated with Power Meters.
3. Power meter shall utilize the acceptable communications protocols identified in this Standard to transfer data to the Enterprise BAS.

ii. Type

1. The power meter shall be fully electronic with a multi-line backlit display showing measured parameters on a local display.

iii. Measurements and Accuracy

1. The power meter shall perform, at minimum, the electrical measurements defined in Appendix A.
2. The power meter shall perform to the accuracy standards provided by the OEM.

iv. Location and Install Requirements

1. The meter shall be located in an accessible and readable location, three to five feet above the finished floor. The mounting position shall be horizontal.
2. The meter shall be installed to the manufacturer's guidelines, accounting for size, amperage, and voltage of the measured line.
3. Each meter shall be equipped with an identification tag indicating the size, location, model, and serial number for the specified electric feed.

- v. Acceptable manufacturer and model for power meter products are any of the following:
 - 1. Schneider Electric, Square D PowerLogic Energy Meter
 - 2. Accuenergy, ACUVIM IIBN Power and Energy Meter
 - a. The ACUVIM IIBN shall be paired with the Accuenergy AcuPanel 9100 when CTs are not built into the electrical switchgear enclosure by the switchgear manufacturer.
 - 3. Electro Industries, Shark 50B/100B Power Meter
- vi. Current Transformers (CTs)
 - 1. The CTs shall be standard 5A secondary and conform to the ANSI Standard accuracy class for metering service of 0.3 or better (revenue metering) with burden B-0.1 to B-2.0 (with burden equal to or greater than that of the installed meter and any other connected equipment).
 - 2. CTs secondary wiring length shall be minimized. The contractor/engineer shall calculate the additional burden of CT wiring and ensure that the total burden of the meter and associated wiring is within the rating of the CTs at the intended accuracy class of 0.3 or better.
 - 3. CT accuracy class shall be sufficient for use in revenue metering with burden equal to or greater than that of the installed meter and any other connected equipment.

E. Natural Gas Metering

i. General

- 1. One or more natural gas sub-meters shall be installed to capture total building natural gas consumption and flow.
- 2. The meter shall have a visual display of measured values and if not, shall be paired with a network communication device with a backlit visual display along with BACnet network communication capabilities.
- 3. The natural gas meter shall be selected based upon the diameter of the line, operating pressure, temperature, mass, and volume requirements of the measured gas line.
- 4. The required enclosure for the meter shall be rated for the environmental conditions it will be exposed to (interior and exterior).

ii. Type

- 1. The natural gas sub-meter shall utilize thermal dispersion or Coriolis technology that is temperature and pressure compensated according to the specifics of the line that is being metered.
- 2. The basis of design for the natural gas meter shall be an insertion or inline thermal mass flow meter.

iii. Measurements and Accuracy

- 1. The natural gas meter shall perform, at minimum, the measurements in Appendix A associated with gas meters.
- 2. The natural gas meter shall perform to the accuracy standards provided by the OEM.
- 3. The natural gas meter shall be selected with the widest possible turndown to ensure that it can cover all anticipated flow variations for the operational flow of the specified line for the highest degree of accuracy.

iv. Location and Install Requirements

23 C BAS Guidelines (rev. 12-05-2024)

1. The meter shall be located in an accessible and readable location, three to five feet off the finished floor if possible. Mounting position shall be horizontal.
 2. Local Display
 - b. Flow meters without a digital backlit display for data visualization shall be coupled with a local flow display for viewing captured data metrics and providing additional BACnet network communications capabilities.
 3. The meter shall be installed to the manufacturer's guidelines, accounting for required straight pipe before and after the meter. A flow conditioner may be required to meet these conditions. Any questions regarding installation should be referred to the local meter representative for confirmation prior to installation.
 4. Required power and mounting shall conform to the manufacturer's recommendations.
 5. Each meter shall be equipped with an identification tag indicating the size, location, model, and serial number for the specified gas line.
- v. Acceptable manufacturer and model for natural gas meter products are any of the following:
1. Fox Thermal, FT2A Thermal Mass Flow Meter
 2. Endress+Hauser, Proline t-mass F 300 Thermal Mass Flow Meter
 3. Onicon, F-5500 Thermal Mass Flow Meter

F. Domestic and Makeup Water

vi. General

1. One or more water flow sub-meters shall be installed to capture at minimum total water flow and consumption for the building.
2. Materials which will be wetted shall be made from non-corrosive materials and shall not contaminate water.
3. Include particulate strainer, isolation valves, and bypass lines where necessary.
4. Required power and mounting shall conform to the original equipment manufacturer's recommendations.

vii. Type

1. The water meter shall utilize electromagnetic measuring technologies.

viii. Measurement and Accuracy

1. The water meter shall perform, at minimum, the measurements in Appendix A associated with water meters (DW and MUW).
2. All water meters will be installed per manufacturer guidelines with sufficient pipe run before and after the flow meter for accurate measurements and perform to the accuracy standards provided by the original equipment manufacturer.
3. The water meter shall be selected with the widest possible turndown to ensure that it can cover all anticipated flow variations for the operational flow of the specified line for the highest degree of accuracy.

ix. Location and Install Requirements

1. Meters shall be installed to provide easy access for reading, maintenance, and repairs.
2. Meters shall be flanged and valved when applicable to permit convenient replacement or calibration of metering device.
3. Each flow meter shall be equipped with an identification tag indicating the size, location, model, and serial number for the specified water line.

4. Local Flow Display
 - a. Flow meters without a digital backlit display for data visualization shall be coupled with a local flow display for viewing captured data metrics and providing additional BACnet network communications capabilities.
- x. Acceptable manufacturer and model for domestic and makeup water meter products are any of the following:
 1. Onicon
 - a. Onicon, F-3200 Inline Electromagnetic Flow Meter
 - i. F-3200 is the preferred Onicon meter for water (particularly domestic) with low flow parameters. Turndown shall be established at 0.05 feet per second for low end velocity applications.
 - b. Onicon, FT-3100 Inline Electromagnetic Flow Meter
 2. Endress+Hauser
 - a. Endress+Hauser, Proline Promag 10W Inline Electromagnetic Flow Meter
 - b. Endress+Hauser, Picomag DMA-series Inline Electromagnetic Flow Meter
 3. McCrometer
 - a. McCrometer, Ultra Mag Inline Electromagnetic Flow Meter
 4. Foxboro, 9500A Inline Electromagnetic Flow Meter
 5. Badger, M2000 Inline Electromagnetic Flow Meter
- xi. The following meters are suggested when physical space is limited for installation:
 1. Endress+Hauser, Picomag DMA-series Inline Electromagnetic Flow Meter
 2. Foxboro, 9500A Inline Electromagnetic Flow Meter
 3. McCrometer, Ultra Mag Inline Electromagnetic Flow Meter

G. BTU Metering (CHW and HHW)

iii. General

1. A BTU meter shall be installed to measure energy delivered for CHW/HHW applications where a chiller/boiler is providing chilled/heating hot water for multiple buildings on campus to provide the ability to measure the overall energy consumption of each building.
2. Total building CHW/HHW energy shall be sub-metered to capture at minimum total building BTU/hr and total energy consumption.
3. BTU meter shall have a visual display of measured variables and if not, shall be paired with a network communication device with a backlit visual display along with BACnet network communication capabilities.
4. BTU meters shall have a minimum warranty of 2 years.
5. Required power and mounting shall conform to the original equipment manufacturer's recommendations.
6. At the express direction of Wake Tech, building thermal energy may be monitored using standard central plant measurement devices (flow and temperature sensors) with calculations performed a) in the JACE through which the associated sensors are integrated, or b) in the Enterprise BAS software if the sensors are not integrated through a JACE. The data used in such calculations must be trended at 15-minute intervals to ensure accurate energy measurement. It is preferred that a building has a dedicated BTU meter.

iv. Type

1. The BTU meter shall include a flow meter; two temperature sensors, one for supply and one for return; a BTU processor; and BACnet network communications capabilities.

2. The BTU meter, flow meter, and temperature sensors shall be from the same OEM and designed to work together for each installed BTU system.
- v. Measurement and Accuracy
 1. The BTU meter shall perform, at minimum, the measurements in Appendix A associated with CHW and HHW BTU meters.
 2. The flow meter shall be sized to read at mid-point for the nominal operating system load. The meter shall not be sized for the maximum capacity of the installed system.
 - vi. Location and Install Requirements
 1. BTU and flow meters shall be installed to provide easy access for readings, maintenance, and repairs.
 2. All BTU meters shall be installed per manufacturer guidelines with sufficient pipe run before and after the flow meter for accurate water measurements.
 3. The required enclosure for the BTU meter shall be rated for the environmental conditions it will be exposed to (interior and exterior).
 4. Each flow & BTU meter shall be equipped with an identification tag indicating the size, location, model, and serial number for the specified meter.
 5. Required power and mounting shall conform to the original equipment manufacturer's recommendations.
 - vii. Acceptable manufacturer and model for BTU meter products are any of the following:
 1. Onicon, System-10 BTU Meter
 - a. Shall include the required temperature sensors for CHW/HHW supply and return temperatures.
 - b. Shall be paired with one of the following Onicon flow meters:
 - i. Onicon, F-3200 Inline Electromagnetic Flow Meter
 - ii. Onicon, FT-3100 Inline Electromagnetic Flow Meter
 - iii. Onicon, F-3500 Insertion Electromagnetic Flow Meter
 - iv. Onicon, F-4300 Clamp-On Ultrasonic Flow Meter
 2. Endress+Hauser, EngyCal RH33
 - a. Shall include the required temperature sensors for CHW/HHW supply and return temperatures.
 - b. Shall be paired with one of the following Endress+Hauser flow meters:
 - i. Proline Promag P 300 Insertion Electromagnetic Flow Meter
 - ii. Proline Promag 10W Inline Electromagnetic Flow Meter
 - iii. Proline Prosonic Flow P 500 Clamp-On Ultrasonic Flow Meter
 3. Badger, FC-5000
 - a. Shall include the required temperature sensors for CHW/HHW supply and return temperatures.
 - b. Shall be paired with one of the following Badger flow meters:
 - i. M2000 Inline Electromagnetic Flow Meter
 - ii. Dynasonics TFX-5000 Clamp-On Ultrasonic Flow Meter

4.7.6 Commissioning of Meter Installations

- A. Each meter integrated to the Enterprise BAS shall be commissioned to verify functionality and accuracy of the parameters defined in this Standard. This includes but is not limited to:
 - i. Verification of successful communications of the meters to the Enterprise BAS.
 - ii. Verification of required live point data at device and server levels.
 - iii. Verification of continuous historical trending at the device and server levels:
 1. Type of historical trend created in the database and required logic.
(Delta vs accumulating)

2. Increments of data storage
 3. Timestamp of data records
 4. Length of data storage at device and server levels
 5. Metrics and measured values for each meter application
- iv. Point to point verification of collected data at the meter, device, and server levels (for water and electrical).
 - v. Review of anticipated life cycle and recalibration time periods for installed meters.

4.7.7 Abbreviations

BACnet IP	<u>B</u> uilding <u>A</u> utomation & <u>C</u> ontrol <u>N</u> etwork - Open Internet (Ethernet) Data Communication Protocol for Building Automation and Control Networks Developed by ASHRAE
BACnet MS/TP	Open Serial Token Passing Protocol for Building Automation Developed by ASHRAE
BAS	Building Automation System
CHW	Chilled Water
DW	Domestic Water
EMIS	Energy Management and Information Systems
HHW	Heating Hot Water
HVAC	Heating, Ventilation, and Air Conditioning
MUW	Makeup Water
NG	Natural Gas
OEM	Original Equipment Manufacturer

4.7.8 Appendix A: excerpt from Wake Tech Point Library Table

	Description	navName	Marker Tags	Point Type	Kind, Precision	Unit	Writability	Graphic	SkySpark	Interval
CHWS BTU Meter	chilled water energy total	chwEnrgTot	water, energy, chilled, total	Sensor	Num, 0	BTU		G		15min
	chilled water entering temp	chwEntTmp	water, temp, entering, chilled	Sensor	Num, 2	°F		G		15min
	chilled water flow rate	chwFl	water, flow, chilled, actual	Sensor	Num, 1	gpm		G		15min
	chilled water leaving temp	chwLvgTmp	water, temp, leaving, chilled	Sensor	Num, 2	°F		G		15min
	chilled water power rate	chwPwr	water, power, chilled	Sensor	Num, 0	BTU/h		G		15min
	chilled water volume total	chwVolTot	water, volume, total, chilled	Sensor	Num, 1	gal		G		15min
NG Meter	gas flow rate	blrGasFl	gas, flow, meter, actual	Sensor	Num, 0	cfh		G		15min
	gas volume total	blrGasVol	gas, volume, meter, total	Sensor	Num, 0	cf		G		15min
	gas temperature	blrGasTmp	gas, temp	Sensor	Num, 1	°F		G		15min
HWS BTU Meter	hot water water energy total	hwWEnrgTot	hot, water, energy, total	Sensor	Num, 0	BTU		G		15min
	hot water water entering temp	hwEntTmp	hot, water, temp, entering	Sensor	Num, 2	°F		G		15min
	hot water water flow rate	hwWFl	hot, water, flow, actual	Sensor	Num, 1	gpm		G		15min
	hot water water leaving temp	hwLvgTmp	hot, water, temp, leaving	Sensor	Num, 2	°F		G		15min
	hot water water energy rate	hwWEnrg	hot, water, energy, actual	Sensor	Num, 0	BTU/h		G		15min
	hot water volume total	hwVolTot	hot, water, volume, total	Sensor	Num, 1	gal		G		15min
DW Meter	domestic water flow rate	dwFl	domestic, water, flow	Sensor	Num, 1	gpm		G		15min
	domestic water volume total	dwVolTot	domestic, water, volume, total	Sensor	Num, 1	gal		G		15min
MUW Meter	hvac make-up water flow rate	hvacMUFl	makeup, water, flow, actual	Sensor	Num, 1	gpm		G		15min
	hvac make-up water flow total	hvacMUFTot	makeup, water, flow, total	Sensor	Num, 1	gal				15min
	chilled water make-up flow rate	chwMUFl	chilled, makeup, flow, water, actual	Sensor	Num, 1	gpm		G		15min
	chilled water make-up flow total	chwMUFTot	chilled, makeup, flow, water, total	Sensor	Num, 1	gal				15min
	hot water make-up flow rate	hwMUFl	hot, makeup, flow, water, actual	Sensor	Num, 1	gpm		G		15min
	hot water make-up flow total	hwMUFTot	hot, makeup, flow, water, total	Sensor	Num, 1	gal				15min
	cooling tower make-up flow rate	ctMUFl	coolingTower, makeup, flow, actual	Sensor	Num, 1	gpm		G		15min
	cooling tower make-up flow total	ctMUFTot	coolingTower, makeup, flow, total	Sensor	Num, 1	gal				15min
Electric Power Meter	active power demand	actPwrDmd	active, elec, power, demand	Sensor	Num, 1	kW		G		15min
	energy total	enrgTot	total, elec, energy	Sensor	Num, 1	kWh		G		15min
	frequency	freq	freq, elec	Sensor	Num, 2	Hz		G		15 min
	line voltage ab	lnVltAB	lineAb, volt, elec	Sensor	Num, 1	V		G		15min
	line voltage bc	lnVltBC	lineBc, volt, elec	Sensor	Num, 1	V		G		15min
	line voltage ca	lnVltCA	lineCa, volt, elec	Sensor	Num, 1	V		G		15min
	neutral current	ntrCur	current, neutral	Sensor	Num, 2	A		G		15min
	phase a active power	phsAActPwr	phase, active, elec, power, lineA	Sensor	Num, 1	kW		G		15min
	phase a current	phsACur	phase, current, lineA	Sensor	Num, 1	A		G		15min
	phase a voltage	phsAVlt	phase, volt, elec, lineA	Sensor	Num, 1	V		G		15min
	phase b active power	phsBActPwr	phase, active, elec, power, lineB	Sensor	Num, 1	kW		G		15min
	phase b current	phsBCur	phase, current, lineB	Sensor	Num, 1	A		G		15min
	phase b voltage	phsBVlt	phase, volt, elec, lineB	Sensor	Num, 1	V		G		15min
	phase c active power	phsCActPwr	phase, active, elec, power, lineC	Sensor	Num, 1	kW		G		15min
	phase c current	phsCCur	phase, current, lineC	Sensor	Num, 1	A		G		15min
	phase c voltage	phsCVlt	phase, volt, elec, lineC	Sensor	Num, 1	V		G		15min
	reactive power	reactPwr	reactive, elec, power	Sensor	Num, 1	VAR		G		15min
	total active power	totActPwr	total, active, elec, power	Sensor	Num, 1	kW		G		15min
	total apparent power	totAppPwr	total, elec, power, apparent	Sensor	Num, 1	kVA		G		15min
	total power factor	totPwrFctr	phase, total, elec, power, factor	Sensor	Num, 2	pf		G		15min

4.7.9 Appendix B: Summary of Approved Meters

Meter Type		Preferred (Basis of Design)		Second Option		Third Option	
		Manufacturer	Model/Series	Manufacturer	Model/Series	Manufacturer	Model/Series
BTU Meter		Onicon	System-10	Endress+Hauser	EngyCal RH33	Badger	FC-5000
BTU Flow Sensor	Inline	Onicon	F-3200/ FT-3100	Endress+Hauser	Proline Promag 10W	Badger	M2000
	Insertion	Onicon	F-3500	Endress+Hauser	Proline Promag P 300		
	Clamp-On	Onicon	F-4300	Endress+Hauser	Proline Prosonic Flow P 500	Badger	Dynasonics TFX-5000
NG Meter		Fox Thermal	FT2A	Endress+Hauser	Proline t-mass F 300	Onicon	F-5500
DW/MUW Meter	Standard	Onicon	F-3200/ FT-3100	Endress+Hauser	Proline Promag 10W	Badger	M2000

	Small	Endress+Hauser	Picomag DMA-series	Foxboro	9500A	McCrometer	Ultra Mag
Electric Power Meter		Schneider Electric	Square D PowerLogic	Accuenergy	ACUVIM IIBN, with AcuPanel 9100	Electro Industries	Shark 50B/100B

4.7.10 Appendix C: Definition of Units for Measurement

A	Amperes (current)
BTU	British Thermal Units (energy)
cf	Cubic feet (natural gas volume)
cfh	Cubic feet per hour (natural gas flow)
Hz	Hertz (frequency)
kWh	Electric consumption - Kilowatt hours, accounting for kW demand
kW	Electric demand - Kilowatt(s) accounting for voltage, amperage, and power factor
kVA	Electrical Apparent Power
pf	Electrical Power Factor
kVAR	Electrical Reactive Power
BTU/hr	British Thermal Units per Hour (energy rate)
gal	Gallons (water volume)
gpm	Gallons per minute (water flow)
°F	Degrees Fahrenheit (temperature)
V	Volts (voltage)

- End of Document -

Figure 1 – BAS Connected Systems Chart

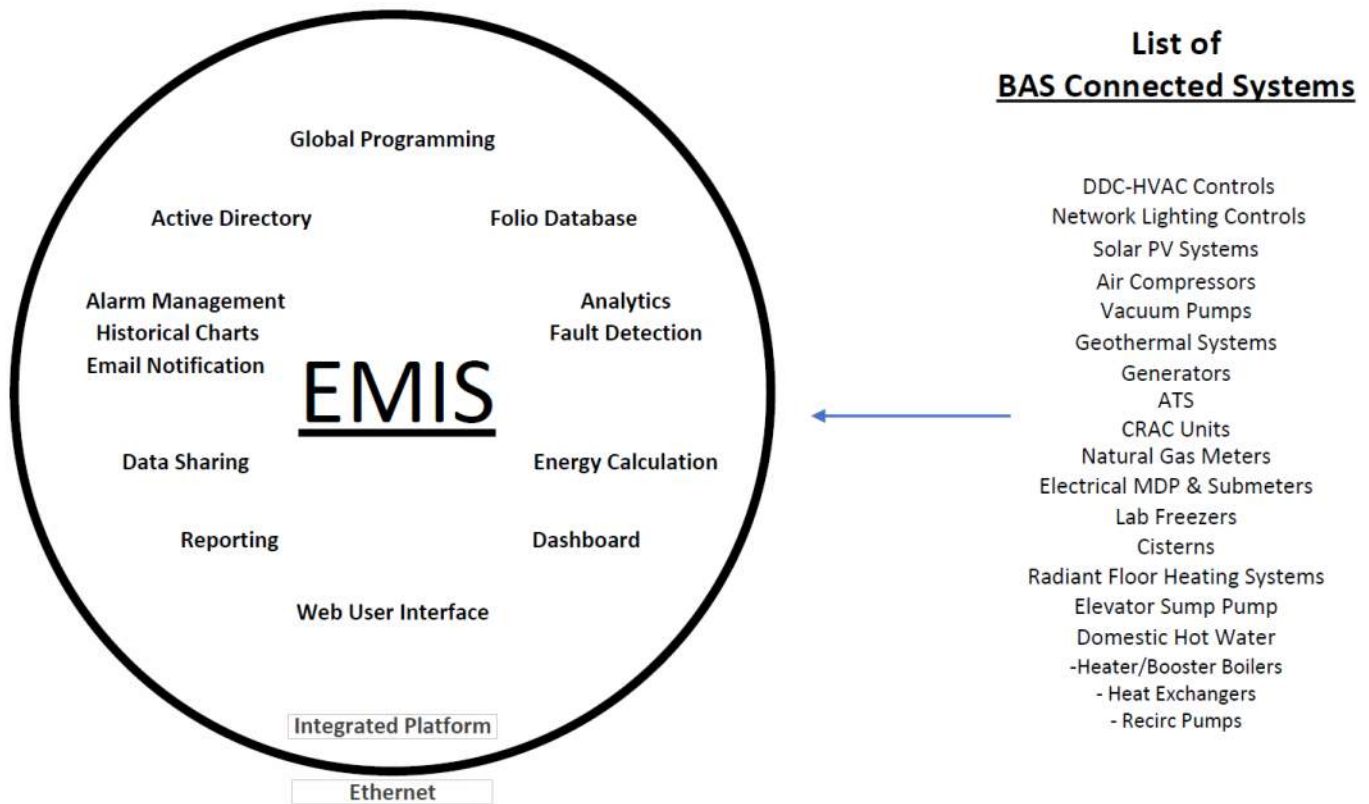
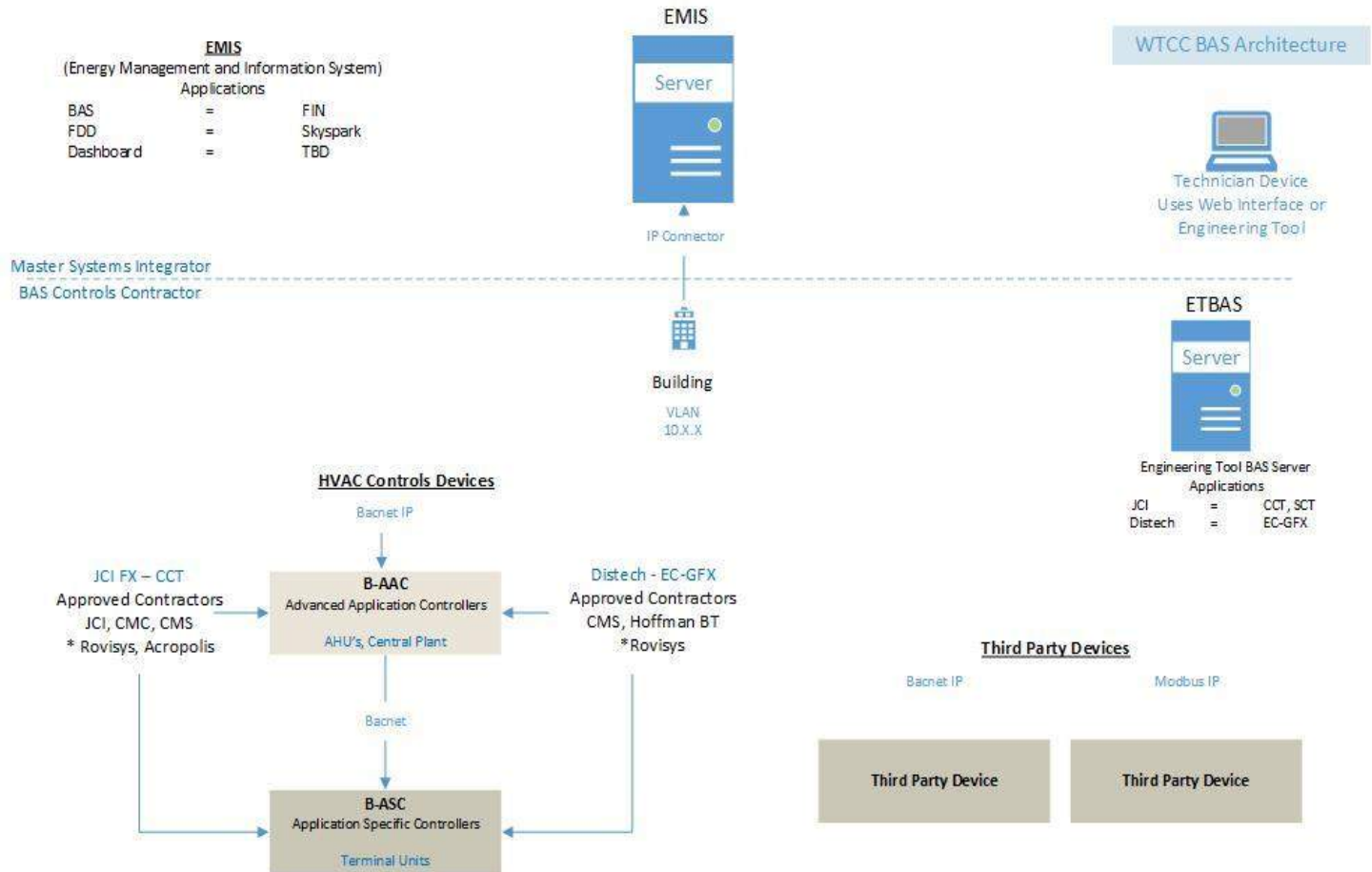


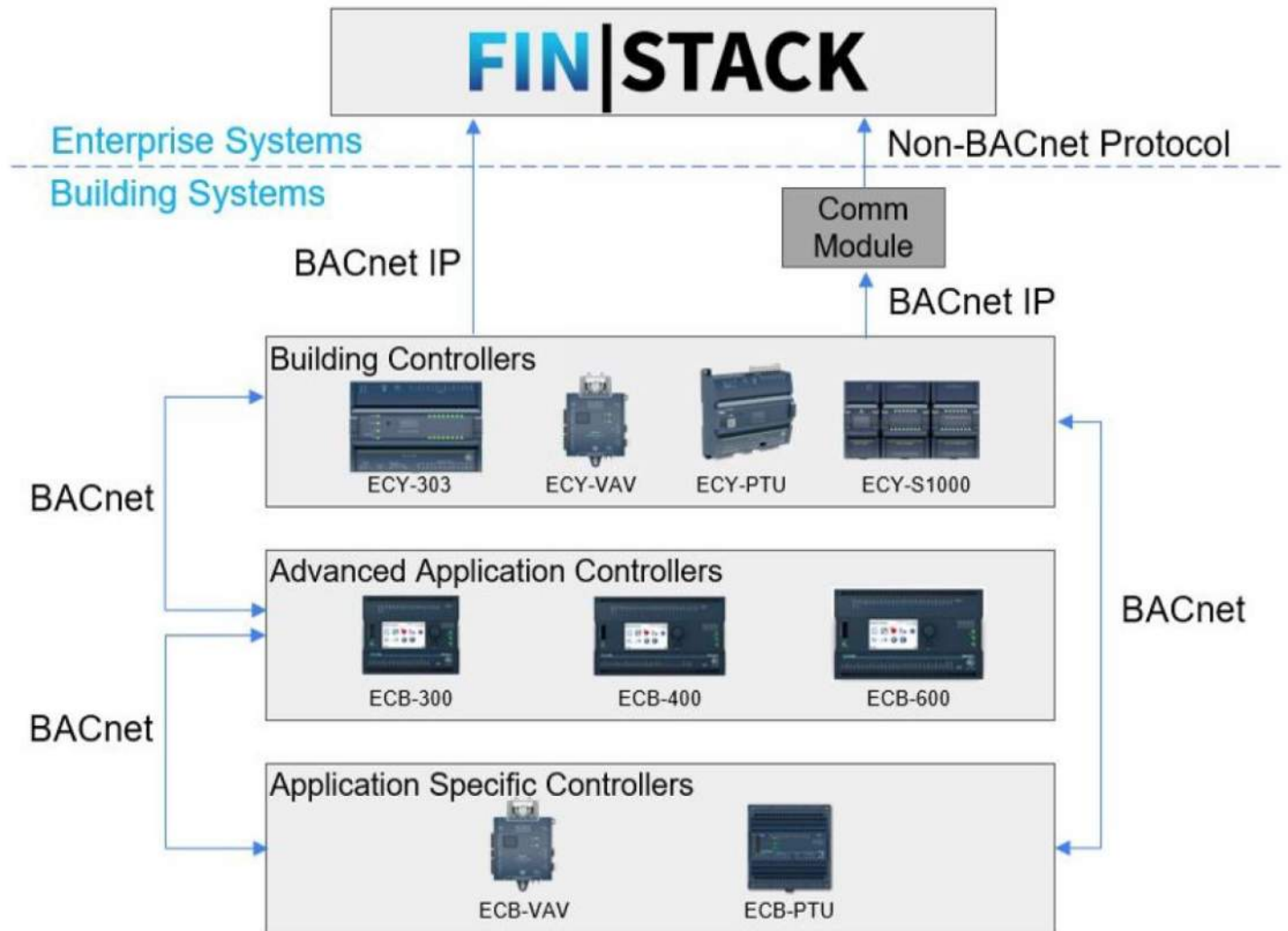
Figure 2 – Wake Tech BAS Network Architecture



Update visio doc. Found at C:\Users\bjmccarthy\OneDrive - Wake Tech Community College\BAS Controls Engineer\BAS Architecture\WTCC BAS Network Architecture4 – Copy.vsd

Figure 3 - Field Controllers Schematic

Distech Field Controllers Schematic



Attachment 1 – BAS Point Library Table

Provided by Wake Tech PM

<K:\facsvcesshare\D&C Admin\Guidelines & Standards\Design Guidelines>

Attachment 2 – BAS Point Library Schematic

Provided by Wake Tech PM

<K:\facsvcesshare\D&C Admin\Guidelines & Standards\Design Guidelines>

Attachment 3 – FIN Point Library Update Procedure

Provided by Wake Tech BAS Controls Engineer

<K:\facsvcesshare\EST\BAS\BAS Software\FIN\MSI Knowledgebase>

Attachment 4 – BAS-MSI Coordination Spreadsheet

Provided by Wake Tech BAS Controls Engineer

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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.

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
Exhaust Ductwork	-2" 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.**

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
+/- 2" W.G.	B

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.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 233100

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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

NFPA Compliance: Comply with applicable provisions of NFPA 90A and/or NFPA 90B pertaining to installation of ductwork accessories.

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.

PART 2 - PRODUCTS

AIRFLOW DAMPERS

Low Pressure Manual (Balancing) Dampers:

Construction: 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.

LOUVERS

All exhaust louvers required to be provided under Division 23 shall be horizontal and drainable, constructed of heavy gauge extruded aluminum, assembled in a neat and substantial manner, properly reinforced, and installed in wall or frame with anchors suitable for installation conditions, as follows:

Louvers shall be designed and installed to withstand wind loading in compliance with Section 019913.

Louvers shall be rated for maximum rain intrusion/entrainment of 0.01 oz/sf of louver free area **at the maximum design intake velocity**. This water penetration rate shall be determined for a minimum 15-minute test duration when subjected to a water flow rate of 0.25 gal/min as described under the "Water Penetration Test" in AMCA 500-L-9913 or equivalent.

Provide 1/2 inch mesh, aluminum birdscreen on inside of all louvers.

All louvers shall have factory finish of etched surface, with final coat of clear acrylic lacquer.

Louvers shall have nominal 6" deep frames shall be standard channel type, 0.081" minimum section, with fixed 37.5° blades.

Contractor shall flash and counter-flash all louvers as required, with flashing to match louver color.

Louver color shall be one of the manufacturer's standard colors as selected by A/E.

Louver shall bear AMCA seal.

PART 3 – EXECUTION

Install louvers level and plumb with flange tight against outside of wall and caulked rain tight. Install wall sleeve where wall thickness exceeds louver depth. Use concealed anchorages where possible. Make louver joints weathertight with concealed gaskets, flashings, joint fillers and sealants.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 233300

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

Cabinet Ventilators: Provide direct-drive centrifugal cabinet exhausters, designed for inline application of type, size and capacity as scheduled on the Drawings, and as specified herein.

Type: Provide galvanized steel housing lined with acoustical insulation. Provide centrifugal fan wheels mounted on motor shaft, with fan shrouds, all removable for service. Provide integral gravity backdraft damper in fan discharge.

Motor: 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 grounded cord and plug.

Electrical: Provide junction box for electrical connection on housing.

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 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 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.

All registers shall be aluminum construction.

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 0.05" thick aluminum 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	Aluminum Construction Model No.
Titus	350FL
Tuttle & Bailey	A70D
Price	630
Nailor	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	Aluminum Construction Model No.
Titus	PAR-AA
Tuttle & Bailey	APG
Price	APDDR
Nailor	4360AA

PART 3 - EXECUTION

INSTALLATION

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. **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 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

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 with edges flanged for recessing in wall.

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: 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

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.

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 heater shall be provided with integral thermostat.

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.

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.

1 **OWNER INSTRUCTION AND TRAINING**

2
3 Provide Owner instruction and training in accordance with Section 019926.
4

5
6 **END OF SECTION 235543**

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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 and outdoor unit with inverter-driven scroll compressor designed for cooling-only or heat pump duty, as indicated on the Drawings.

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: Construct fins of continuous aluminum or copper configured plate-fin type, as indicated on the Drawings. Provide minimum thickness of .0075". Construct tubes 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. Construct casing 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. 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: Construct fins of continuous aluminum or copper configured plate-fin type, as indicated on the Drawings. Provide minimum thickness of .0075". Construct tubes 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. Construct casing 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: 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.

Condensate Drain: 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.

1 Electrical Connection: System shall be configured for a single electrical power service connection to the outdoor unit,
2 with electrical service to be provided from the outdoor unit to the indoor unit utilizing factory-provided electrical
3 connections. Make electrical connections in accordance with Section 230511.
4

5 Controls: A microprocessor-based controller shall be incorporated for system control, responding to inputs (setpoint,
6 operating mode, schedule, etc.) from a wall-mounted, wireless device located where indicated on the Drawings. The
7 controller shall sense the return air temperature, the indoor coil temperature and control both indoor and outdoor unit
8 operation to maintain space temperature setpoint. For heat pump units, changeover from heating to cooling and the
9 reverse shall be automatic.
10

11 **PART 3 - EXECUTION**

12 **INSTALLATION**

13
14
15
16 Install units where indicated, in accordance with equipment manufacturer's published installation instructions, and
17 with recognized industry practices, to ensure that units comply with requirements and serve intended purposes.
18 Arrange installation to provide access space around units for service and maintenance.
19

20
21 Coordinate piping installations and specialty arrangements with schematics on the Drawings and with requirements
22 specified above for refrigerant piping systems. Install piping adjacent to unit to allow for required access for service
23 and maintenance.
24

25 Provide condensate drain piping and terminate drains outdoors or at floor drains as indicated on the Drawings.
26

27 Make electrical service connection in accordance with Section 230511.
28

29 Do not operate unit fans until filters are in place.
30

31 Touch-up factory exterior paint as required to repair scratches or other damage.
32

33 **OWNER INSTRUCTION AND TRAINING**

34
35 Provide Owner instruction and training in accordance with Section 019926.
36
37

38 **END OF SECTION 238116**
39

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SECTION 251510 – ENERGY INFORMATION MANAGEMENT SYSTEMS
(EMIS)

PART 1 - GENERAL

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Section, apply to this Section.
- B. Section 230913, which specifies the requirements for sensors, devices, actuators, and final control elements utilized by the DDC system.
- C. Section 230510 – HVAC Basic Requirements
- D. Section 230923 – “Direct Digital Control Systems for HVAC” Sets forth the requirements of the System Integrator (Controls contractor) who shall work closely with the Master System Integrator to seamlessly integrate the enterprise BAS front end to the field controllers (and building supervisory controllers, when present).
- E. Section 230993 –Sequence of Operation.
- F. Section 260000 - “Electrical” specifies electrical power system, Lighting, Lighting control and other electrical systems.
- G. Section 270000 - “Data Communication Systems”

1.02 DESCRIPTION

- A. Scope: This section contains general requirements for providing Master System Integration and control programming elements for control systems provided elsewhere in these specifications. MSI is responsible for all alarming and trending including alarming as specified in 230993.
- B. Purpose: Energy monitoring, process control, remote start/stop and remote set point adjust control of exhaust fans and other items as specified and as shown on the drawings.
The existing EMIS is thin-client architecture to provide operators complete access to the control system via a web browser.

Work Specified in this Section:

- a. Test, calibrate and commission entire control system and its components.
 - b. Train Owner personnel in the operation, maintenance and service of the control system as it pertains to the new systems installed by this project.
- C. The EMIS at Wake Tech shall be developed by an MSI via open collaboration with the BAS contractor. BAS/MSI milestones shall be included in construction schedules and in OAC meetings. EMIS consistency shall be maintained with every project integration. Wake Tech has developed a spreadsheet template that can help the Contractor to manage the coordination of this work. Appendix-A in specification 230923 has the WTCC BAS Guidelines. The contractor shall bring to the attention of the college and the engineer, any discrepancies between this specification or other parts of these contract documents and the current BAS guidelines for resolution. Some, but not all of the BAS guidelines are incorporated into this specification. All requirements of the guidelines are to be followed regardless of whether they are repeated in this specification. The MSI shall attend OAC meetings when required and/or requested to report on project progress and coordination between the BAS contractor and themselves.
- D. MSI shall hold a Controls Integration Meeting with the BAS contractor, all third party equipment manufacturers with controls to be integrated into the BAS. This meeting shall be held prior to the BAS control submittal. MSI shall meet regularly with BAS contractor to obtain network controller IP/MAC/BACnet ID info and point lists per device to perform integration. The MSI shall hold regularly scheduled progress meetings and include WTCC. MSI will perform turnover training for graphics, alarming, scheduling, trending, analytics, and O&M documents. MSI shall coordinate their training with BAS contractor. Prior to functional testing and to training, MSI shall integrate Project into SkySpark (See WTCC BAS Guidelines in Appendix A of Section 230923 for more requirements and information and Appendix A in this specification for current rules). Existing points for deleted controllers shall be deleted from database. MSI will use a mixture of existing rules and new rules to cover a Level 30 alarm requirement. EUI Dashboards shall be updated.

Table 4.2 BACnet Alarm Level - Notification Table

BACnet Alarm Level	WTCC Alarm Priority	Notification
10	A1	Email sent to WTCC & MCSP, Call center notified.
15	A1 & IT	Email sent to WTCC & MCSP, Call center & IT notified.
20	A2	Email sent to WTCC & MCSP.
30	Default	No notification. Programmed as Skyspark rules and viewed on Spark or KPI Dashboard.

1.03 QUALITY ASSURANCE

- A. References: This section contains references to the following documents that are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section prevail:
1. ASHRAE Automatic Control Terminology for Heating, Ventilating, Air Conditioning
 2. ASHRAE BACnet Standard for Automation Protocol
 3. ASME MC85.1 Terminology for Automatic Control
 4. API RP 550-85 Installation of Instruments and Control Systems
 5. ISA S5.4-76 Diagram & Instrument Loop standards
 6. ISA S5H-79 Process Instrumentation Terminology
 7. NEMA EMC1 Energy Management System Definitions
 8. NEMA ICS 1-83 General Standards for Industrial Control and Systems
 9. NEMA ICS 2-83 Industrial Control Devices, Controllers, and Assemblies
 10. C2-90 National Electrical Safety Code
 11. Title 19 State Fire Marshall Regulations
 12. 70-93 National Electrical Code (NEC)
 13. NFPA 101-91 Life Safety Code
- B. Programmer: Company specializing in programming the work of this section with minimum three (3) years of application programming experience and start-up of the distributed digital control system proposed.
- C. Provide complete integration of equipment including serial digital equipment interfaces and software drivers to form a complete and comprehensive control environment.

1.04 DEFINITIONS

Term	Definition
MSI Contractor	Master Systems Integrator Contractor who is responsible for execution of the requirements contained in Division 25.
BACnet Interoperability Building Blocks (BIBB)	A BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBS are combined to build the BACnet functional requirements for a device in a specification.
BACnet/BACnet Standard	BACnet communication requirements as defined by the latest version of ASHRAE/ANSI 135 and approved addenda.
Control Systems Server	A computer(s) that maintain(s) the system configuration and controller program database.
Controller	Intelligent stand-alone control device. Controller is a generic reference to system controllers, general application controllers, and configurable application controllers.
Distributed Digital Control	Microprocessor-based control including Analog/Digital conversion and program logic in a stand-alone networked environment.
Gateway	Bi-directional protocol translator connecting control systems that use different communication protocols.
Local Area Network	Computer or control system communication network limited to intranets (single building or campus of buildings).
Master-Slave/Token Passing	RS-485 based data link protocol as defined by the BACnet standard.
Point-to-Point	Serial communication as defined in the BACnet standard.
Primary Control LAN	High speed, peer-to-peer controller LAN (Ethernet, ARCnet, other) connecting SCs and optionally AACs and ASCs. Refer to System Architecture below.

Term	Definition
Protocol Implementation Conformance Statement	A written document that identifies the particular options specified by BACnet that are implemented in a device.
Router/Switch	A device that connects two or more networks at the network layer that can route data packets intelligently from one node to another.
Virtual Network	A LAN that runs over a standard Ethernet link using BACnet data packets wrapped in a cloak as if a separately wired network were applied. Used to separate control network traffic from enterprise network traffic when using the same hardwired or wireless link.
VPN	Virtual Private Network providing remote access to control intranets through firewalls from the internet using a secure interface.
Wiring	Raceway, fittings, wire, boxes and related items.

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.

Control Drawings: MSI Contractor submittal requirements. MSI will create submittal based on BAS contractor approved submittal to include the following:

1. Title Page
2. Database (points, trends, and alarms)
3. Graphics
4. Summaries
5. Schedules
6. Skyspark additions/changes

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.

PART 2 – PRODUCTS

Approved Master System Integrators:

1. Essex Consulting Group
2. CMS
3. Building Control Solutions

EMIS – Energy Management Information Systems

EMIS Overview

Energy Management and Information Systems - a broad family of tools and services to manage commercial building energy use. These technologies include, for example, energy information systems, equipment-specific fault detection and diagnostic systems, benchmarking and utility tracking tools, automated system optimization tools, and building automation systems.

Enterprise BAS Application

Overview

WTCC has chosen FIN Stack (FIN), developed by J2Innovations – a wholly owned subsidiary of Siemens AG, as the BAS enterprise software hosted on a WTCC server. FIN is designed to be open; supporting all the major protocol standards used in buildings today, to enable integration with multiple building level systems and IoT deployments.

It is WTCC's goal to integrate from high level field controllers (e.g., a B-BC or B-AAC) to a FIN front end server to be a single location to view graphics, and interact through point overrides, and to manage

alarming, scheduling and trending (AST). FIN leverages the project Haystack open-source metadata protocols by using tagging to automate configuration processes and deliver context-sensitive information to give a highly intuitive user experience. This allows building systems from various distributors to be integrated into a unified system in order to provide flexibility for expansion, maintenance, and service of the BAS system. The Owner, Wake Technical Community College, shall be the named license holder of all software associated with any and all incremental work on the projects.

Virtual Server Requirements (No new hardware, software, licenses are required. The following section supercedes the guidelines in the appendices.)

The Enterprise server is currently running Windows Server 2016.

FIN Stack Framework Software

1. Scheduling/Calendars

Primary schedules shall be written from FIN and pushed down to field controllers and building supervisory controllers.

- Event Schedules: Examples of what shall be programmed from FIN are; Holidays, Campus Closures, and Weather Calendar. For control option C2, the MSI shall coordinate with WTCC to set these schedules.

2. Point Naming

Use of WTCC preferred naming convention and Haystack 4.0 Naming Convention.

3. Alarming

All alarm logic shall be programmed in FIN. It shall be the responsibility of the MSI to program any new alarms associated with this project. Notifications will be provided by the front-end system.

- (BACnet Alarm Levels 10)
 - Immediate notifications sent to
 - 1. WTCC Facility Managers – 24/7
 - 2. MCSP technicians – 24/7
 - 3. On Call Center - M-F from 4pm to 7am. 24/7 weekends and holidays.
- (BACnet Alarm Levels 15)
 - 1. WTCC Facility Managers – 24/7
 - 2. MCSP technicians – 24/7
 - 3. WTCC IT Staff – 24/7
 - 4. On Call Center - M-F from 4pm to 7am. 24/7 weekends and holidays.
- (BACnet Alarm Levels 20)
 - 1. WTCC Facility Managers – 24/7
 - 2. MCSP technicians – 24/7
- Prior to building turnover to WTCC, the notifications shall be routed by a new SC-GC alarm topic. Alarm Classification/Priority
Refer to [Table 4.2a-Critical Alarms](#) of Wake Tech's BAS Guideline
- Alarm Notifications
Refer to the [Table 4.2 BACnet Alarm Level – Notification Table](#) Guideline for notification categories.

4. Trending

Digital Trends

- enable the history,
- allow the hisCollectCov
- hisType: Collected

Analog Trends

- enable the history type
- hisType: Collected
- hisCollectInt: set for 15 minutes

Graphics

The Master System Integrator (MSI) will define and create fully developed graphics for end user to operate, troubleshoot and maintain BAS controlled HVAC equipment.

5. Documentation

- Record mechanical, electrical, and BAS Documentation Drawings shall be loaded onto the Enterprise Server and be available in FIN through an O&M application on the Building SC Building Graphics. These documents shall be available on any screen of Building SC.

FIN Action Categories and Permission Levels

Writable points in FIN are commanded through Actions. A gear symbol is used in graphics to show that a point has actions, and the gear can be clicked on to bring up the action choices for each point set as a "Set Value" choice in BAS software. An example is shown below for an AHU Supply Fan command.



Within FIN, Action categories are permissions with priority increasing in direct proportion to the number. That is, Permission 9 takes precedence over Permission 6 in FIN. Note that this is opposite from BACnet and Niagara where write level priority, a number from 1 to 16, is inversely proportional to the number (Niagara write level 9 overrides level 16).

The Contractor must understand that all values from FIN to the BAS are set to haystackWrite / bacnetWrite level in9.

Action category permissions work in conjunction with the user action access permission property tag which set users' permissions at "Set" (<=9), "Manual" (<=6), and "Emergency" (<=9). FIN users are only provided Actions that are at or below their username Access permission. For example, a user with Access Permission 6 does not have access to Permission 9 Actions.

The Master System Integrator (MSI) shall recognize the following FIN Action and Permission setup and use it to integrate buildings to FIN unless notified by the WTCC Project Manager or BAS Engineer to use other Action settings:

String Points		Bool Points	
Default Action Display	HVAC Permission	Default Action Display	HVAC Permission
Emergency Set	9	Emergency Active	9
Emergency Auto	9	Emergency Inactive	9
Manual Set	6	Emergency Auto	9
Manual Auto	6	Manual On	6
Set Default	9	Manual Off	6
Set Null	9	Manual Auto	6
		Set Default	9
Enum Points		Numeric Points	
Default Action Display	HVAC Permission	Default Action Display	HVAC Permission
Emergency Set	9	Emergency Set	9
Emergency Auto	9	Emergency Auto	9
Manual Set	6	Manual Set	6
Manual Auto	6	Manual Auto	6
Set Default	9	Set Default	9
Set Null	9	Set Null	9

Remember that no matter what the above FIN Action Permission levels are, all FIN Actions are written to building level BAS at haystackWrite / bacnetWrite level in9.

PART 3 - EXECUTION

The Master System Integrator shall follow the requirements of the current version of the WTCC BAS guidelines Section 3 EMIS – Energy Management Information Systems and consult with the WTCC Project Manager and BAS Engineer when providing MSI services.

The EMIS at Wake Tech shall be developed by an MSI via open collaboration with the BAS contractor. BAS/MSI milestones should be included in construction schedules and in OAC meetings. EMIS consistency shall be maintained with every project integration. On all projects Wake Tech prefers one company, ideally either GC or Mechanical Contractor, to contract both BAS and MSI companies. Wake Tech has developed a spreadsheet template that can help either GC or Mechanical Contractor to manage the coordination of this work.

The MSI contractor is to review all contract documents including drawings, specifications, and submittals related to the BAS and associated equipment including but not limited to those referenced above and is responsible for the entire scope as it relates to the MSI contractor therein.

Graphics

The Master System Integrator (MSI) will define and create fully developed graphics for end user to operate, troubleshoot and maintain BAS controlled HVAC equipment.

- Documentation As built Documentation Drawings shall be loaded onto the Enterprise Server and be available in FIN through a hyperlink on Building Homepage Graphics.

Alarms

All alarms are programmed by MSI.

Alarming Overview: (Contractor shall obtain Alarm priorities from the WTCC Project Manager) These alarms will be synched to the EMIS using standard BACnet protocol when the field controller is connected to the network. Notifications of these alarms will be sent out via FIN front end. Alarm extensions shall be created and prioritized according to (WTCC) BAS Alarm Standards. Operators with sufficient privilege shall be able to read and write alarm parameters for all standard BACnet alarm types. Operators with sufficient privilege shall be allowed to change routing (BACnet notification classes) for each alarm including the destination, time delay, priority class, day of week, time of day, and the type of transition involved.

Alarms shall be programmed with time delays and other logic to prevent nuisance tripping. Elimination of nuisance alarm notifications is a priority at (WTCC).

In order for alarm notifications to be sent to the correct email recipients, the Designer and Contractor shall use BACnet alarm levels shown in the BACnet Alarm Level – Notification Table below.

Table 4.2 BACnet Alarm Level – Notification Table

BACnet Alarm Level	WTCC Alarm Priority	Notification
10	A1	Email sent to WTCC & MCSP. Call center notified.
15	A1 & IT	Email sent WTCC, MCSP. Call Center & IT notified.
20	A2	Email sent to WTCC & MCSP.
30	Default	No notification. Programmed as Skyspark rules and viewed on Spark or KPI dashboards.

Use BACnet notification class divisions to assign priorities to alarms and use the Alarm Level Mapping shown in [Table 4.2a](#) below for alarm notifications.

Critical Alarms

(WTCC) maintains a Critical Alarm List. Contractors shall obtain the current list from the WTCC Project Manager. [Table 4.2a](#) below displays a list of Critical Alarms that shall be programmed into each B-AAC or B-BC.

Coordinate all critical alarms with WTCC, including critical alarms for the building.

Table 4.2a Critical Alarms Table

Miscellaneous	IT-MDF Room High Temp	Upon activation	None/None	A1
---------------	-----------------------	-----------------	-----------	----

Default Alarms

Default alarms will be programmed and visualized in SkySpark. See WTCC BAS Guidelines in Appendix A for more information.

Closeout Submittals:

Redlined as-built drawings with any changes made during integration. Any corrections requested by WTCC shall be made and resubmitted.

3.01 ADJUSTMENTS

- Adjust controls and equipment to maintain the conditions indicated, to perform and to operate in the sequences specified.
- Adjust values after installation for optimal operation and intuitive manner.

3.02 WORKSTATION DATABASE AND GRAPHICS GENERATION

- Database: Prepare and enter database and complete the programming for automatic control functions for the owner as called for in the Sequence of Operation and Control Drawings.
- Color Graphics: Create and enter color graphics for each mechanical system including dynamic point database required for each input/output required.
 - Color graphic screens shall be created to match existing graphics for similar equipment and systems currently on the EMIS, P&I diagrams and AHU airflow detail as shown on design Drawings.
 - Generate color graphics showing system schematics for each building and for its respective heating and cooling plants.

Create floorplan graphics using the standard FIN graphic package based on approved control drawings. PDF or .dwg floor plans will be provided to the MSI.

Graphics Required:

1. Campus homepage (edit) to include bldg.
 - a. Bldg./Site will be referred to as EE.
 - b. Site description will be WTCC - WTE - 890-07088 - EF2-Fire & Rescue RR
2. Homepage graphic. (new) Coordinate with WTCC for Bldg. image.
3. Floorplan graphic. (new) Zones shall include temp and reference effective zone temp set point to allow for zone highlighting program to reflect warm/cold areas. Include DSSI-1info for room 105.
4. Equipment graphic. (new) Provide one template for room(s) 101, 102, 103, & 104. That includes info for both EF and temp, temp set point, occupancy.
5. Fire and Rescue Training Facility shall be added to the existing energy dashboard to allow manual input of utility bill information similar to current buildings using the energy dashboard in Skyspark.

3.03 TRENDING

Native Trending

At a minimum, provide programming and trending for Points as follows:

- 1) Create extensions for physical input and output in the system. The TL objects should reside in a B-BC, B-AAC or B-ASC field controller. Refer to Wake Tech's Points Library Table for list of points that shall be trended.
- 2) With the exception of points identified below, analog data shall be trended on a 15-minute interval. This includes but is not limited to analog inputs, outputs, and automatically resetting set-points. Examples include space temperatures, PID loop inputs and outputs,
- 3) Boolean data points shall be trended on change of value (CoV): inputs and outputs.
- 4) Each B-AAC and B-BC field controller shall be capable of storing all trend data locally for a minimum of 3 days and preferably for 5 days. Trend data for B-ASC devices must be stored in these high-level controllers if the B-ASC device cannot store and pass along trends to the EMIS server.
- 5) Trend data shall be synced to the EMIS server for input to the College's data historian. Currently the data historian resides on the SkySpark platform. Trend data may be pulled from field controllers by FIN or SkySpark or other applications.

Coordinate all trend times and storage durations with owner. Most stringent trend intervals (shortest interval) specified in the documents shall be maintained.

3.04 TESTING

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.

3.05 TRAINING

- A. Provide a training outline to the Owner prior to scheduling training sessions.
- B. Training sessions shall be provided for the Owner's personnel by factory trained control system engineers, programmers and technicians.

- C. Conduct training courses for the designated Owner's personnel in the maintenance and operation of the control system.
- D. Include instruction on specific systems and instructions for operating the installed system to include as a minimum:
 - 1. Sequence of operation.
 - 2. Operation of control system.
 - 3. Function of each component.
 - 4. System operating procedures.
 - 5. Programming procedures.
 - 6. Maintenance procedures.
 - 7. Alarm procedures.
 - 8. Trending procedures.
 - 9. Emergency restart and local override.
- E. Provide telephone support and answer questions throughout the two-year warranty period.

END OF SECTION

APPENDIX A

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	Topic	Notes	Notes cont'd
1	Rules-Enabled/Disabled	Rules Enabled developed by Essex. WTCC is interested in adding new Rules.	
2	Disabled Rules Tab.	Rules have not been verified.	First place to look to see if possible new rule is already in Skyspark, but just disabled.
3	New Rules	1. make up for default alarms in BAS 2. identify equipment underperformance from ASHRAE Guideline 36 3. Rule Type will need to be discussed with WTCC. (Wendell, Chris, & Brian) 4. Weights will need to be discussed with WTCC. (Wendell, Chris, & Brian)	
4			
5			
6			
7			
8			
9			
10			

ENABLED RULES

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SAMET

id	color	dis	disabled	enabled	help	rule	sparkRule	weight	kpiRule	ruleCost	ruleFunc	ruleInUse	ruleOn	targetRule	mod
1- VAV Space Temp Within 70-73 Degree Range KPI	#34495e	1- VAV Space Temp Within 70-73 Degree Range KPI		✓	percentage of time that space temp is inside of 70-73 degree range (only during occupancy)	✓			✓		kpi_SpaceTempOutOfRange	✓	equip and (vav or (ahu and directZone))		16-Sep-2024 Mon 10:42:09AM UTC
2- VAV Space Temperature Within 4 Degrees of Setpoint KPI	#e74c3c	2- VAV Space Temperature Within 4 Degrees of Setpoint KPI		✓	percentage of time that the space temp is within 4 degreesof its specified setpoint (during occupied times)	✓			✓		spk_spaceTempPerformance(...,false,4.0,true)	✓	equip and (vav or (ahu and directZone))		22-Aug-2024 Thu 4:04:17PM UTC
3- VAV Discharge Airflow Performance KPI	#16a085	3- VAV Discharge Airflow Performance KPI		✓	percentage of time that the discharge airflow is within 15% of its specified setpoint (during occupied times)	✓			✓		kpi_DischargeAirflowPerformance	✓	vav and equip		16-Sep-2024 Mon 11:36:48AM UTC
4- AHU Supply Air Temp Performance KPI	#9b59b6	4- AHU Supply Air Temp Performance KPI		✓	percentage of time that the ahu supply air temperature is within 3 degrees of its specified setpoint (during occupied times)	✓			✓		kpi_AhuSATperformance	✓	equip and ahu		16-Sep-2024 Mon 11:41:24AM UTC
5- AHU Static Pressure Performance KPI	#95a5a6	5- AHU Static Pressure Performance KPI		✓	percentage of time that the static pressure of the discharge air is within 15% of its specified setpoint (during occupied times)	✓			✓		kpi_DischargeAirStaticPressurePerformance	✓	equip and ahu and vavZone		16-Sep-2024 Mon 11:45:14AM UTC
6- Chiller Plant Temperature Performance KPI	#3498db	6- Chiller Plant Temperature Performance KPI		✓	percentage of time that chilled water discharge temp is within 3 degrees of its specified setpoint (during occupied times)	✓			✓		spk_chillerDischargeTempPerformance(...,false,3.0,true)	✓	equip and chiller		30-Aug-2024 Fri 8:06:46PM UTC
AHU Chilled Water Valve Failure (Stuck Closed)	#95a5a6	AHU Chilled Water Valve Failure (Stuck Closed)		✓	AHU Valve position was set to fully open (100%) and the discharge air temperature is more than the acceptable 3 degree differential from the setpoint.	✓	✓	1			ahuChwValveStuckClosed	✓	equip and ahu and chilledWaterCooling		16-Sep-2024 Mon 11:12:07AM UTC
AHU Chilled Water Valve Failure (Stuck Open)	#95a5a6	AHU Chilled Water Valve Failure (Stuck Open)		✓	AHU Valve position was set to fully closed (0%) and the discharge air temperature is less than the acceptable 3 degree differential from the mixed air temp.	✓	✓	1			ahuChwValveStuckOpen	✓	equip and ahu and chilledWaterCooling		16-Sep-2024 Mon 11:12:07AM UTC
AHU Fan Off While Occ	#3498db	AHU Fan Off While Occ		✓	AHU Fan Stopped While Occupied	✓		10			ahuStoppedWhileOcc	✓	equip and ahu	✓	16-Sep-2024 Mon 11:27:25AM UTC
AHU Fan Running 24/7	#3498db	AHU Fan Running 24/7		✓	This spark finds all the instances where an ahu is running for 24 hrs	✓	✓	9			spark_AHUFanRunning	✓	equip and ahu	✓	16-Sep-2024 Mon 11:27:25AM UTC
AHU Running While Unocc	#3498db	AHU Running While Unocc		✓	AHU fan is on while occupied command is off.	✓		8			ahuRunningUnocc	✓	equip and ahu	✓	22-Oct-2024 Tue 4:45:14PM UTC
AHU Static Pressure Performance	#9b59b6	AHU Static Pressure Performance		✓	periods when the static pressure of the discharge air is outside 15% of its specified setpoint (during occupied times)	✓	✓				spk_dischargeAirStaticPressurePerformance(...,false,0.15,false)	✓	equip and ahu and vavZone		30-Aug-2024 Fri 7:01:20PM UTC
Chiller Leaving Setpoint is Too High	#e74c3c	Chiller Leaving Setpoint is Too High		✓	The chiller leaving setpoint is set above the expected maximum.	✓	✓	9			spk_chwTooHigh	✓	equip and chiller		22-Aug-2024 Thu 3:59:16PM UTC
Chiller Leaving Setpoint is Too Low	#3498db	Chiller Leaving Setpoint is Too Low		✓	The chiller leaving setpoint is set below the expected minimum.	✓	✓	9			spk_chwTooLow	✓	equip and chiller		22-Aug-2024 Thu 3:59:16PM UTC
Chiller On but Insufficient Flow	#e844ad	Chiller On but Insufficient Flow		✓	Chiller Enable point is reading true while flow point is reading less than 50 gal/min	✓	✓				jg_chillerOnButNoFlow	✓	equip and (chillerPlant or chiller)		22-Aug-2024 Thu 3:19:51PM UTC
CHW Diff Pressure Varying from SP	#e844ad	CHW Diff Pressure Varying from SP		✓	CHW DP off by more than 7 psi of setpoint	✓	✓				jg_diffPress	✓	equip and (chillerPlant or chilled or equipRef->chillerPlant)		3-Jul-2024 Wed 10:55:00PM UTC
CHW Insufficient Cooling	#d35400	CHW Insufficient Cooling		✓	Chilled Water Secondary Return temperature is less than three degrees F above Chilled Water Secondary Supply temperature	✓	✓				jg_lowDeltaT	✓	equip and (chillerPlant or chilled or equipRef->chillerPlant)		3-Jul-2024 Wed 10:55:00PM UTC
Fan Running 24/7	#1abc9c	Fan Running 24/7		✓	This finds all fans that are running for more than 23hrs	✓	✓	9			spark_FanRunning	✓	(vav or fcu) and not underConstruction	✓	3-Jul-2024 Wed 10:55:00PM UTC
Faulty OAH Sensor	#3498db	Faulty OAH Sensor		✓	Outside Air Humidity is above 100% or below 0% for longer than 30 minutes	✓	✓	3			spark_faultyRelHumSensor	✓	outside and air and humidity and sensor and point and not underConstruction	✓	8-Aug-2024 Thu 1:09:06PM UTC
Faulty OAT Sensor	#3498db	Faulty OAT Sensor		✓	Sensor is more than 7 degrees off the weather data or > 120 degrees	✓	✓	4			faultyOATSensor	✓	ahu and not underConstruction	✓	3-Jul-2024 Wed 10:55:00PM UTC
High CO2	#c0392b	High CO2		✓	CO2 Point is above 1000 ppm for longer than 30 minutes consecutively.	✓	✓	4			spk_highCO2	✓	equip and (vav or ahu) and not underConstruction	✓	3-Jul-2024 Wed 10:55:00PM UTC
High Humidity	#c0392b	High Humidity		✓	Humidity Point is above 65% for longer than 30 minutes consecutively.	✓	✓	8			spk_highHumidity	✓	equip and (ahu or vav) and not underConstruction	✓	3-Jul-2024 Wed 10:55:00PM UTC
KPI AHU Discharge Temp	#e67e22	KPI AHU Discharge Temp		✓	KPI to find the min and max of the discharge air temp of any AHU	✓			✓		kpi_DischargeTemp	✓	equip and ahu		26-Aug-2024 Mon 6:13:33PM UTC
KPI AHU Fan Runtime		KPI AHU Fan Runtime		✓		✓			✓		kpi_FanRunTime	✓	ahu		3-Jul-2024 Wed 10:55:00PM UTC
KPI Boiler Discharge Max Temp	#c0392b	KPI Boiler Discharge Max Temp		✓	KPI Boiler Discharge Min and Max Temp	✓			✓		kpi_BoilerDischargeMaxTemp	✓	boiler		3-Jul-2024 Wed 10:55:00PM UTC
KPI Boiler Return Max Temp	#c0392b	KPI Boiler Return Max Temp		✓	Boiler Return Min and Max Temp	✓			✓		kpi_BoilerReturnMaxTemp	✓	boiler		3-Jul-2024 Wed 10:55:00PM UTC
KPI Chiller Discharge Min Max	#3498db	KPI Chiller Discharge Min Max		✓	KPI Chiller Discharge Temp Min Max	✓			✓		kpi_ChillerDischargeMax	✓	chiller		3-Jul-2024 Wed 10:55:00PM UTC
KPI Chiller Return Temp Max	#3498db	KPI Chiller Return Temp Max		✓	Chiller Return Temp Min and Max	✓			✓		kpi_ChillerReturnMaxTemp	✓	chiller		3-Jul-2024 Wed 10:55:00PM UTC
KPI FCU Fan Runtime		KPI FCU Fan Runtime		✓		✓			✓		kpi_FanRunTime	✓	fcu		3-Jul-2024 Wed 10:55:00PM UTC
KPI Standard Setpoint Compliance		KPI Standard Setpoint Compliance		✓	Setpoints for Summer >= 73 and Setpoints for Winter <= 70	✓			✓		kpi_StandardSetpointCompliance	✓	zone and air and temp and sensor and equipRef->vav and not discharge		3-Jul-2024 Wed 10:55:00PM UTC
KPI Supply and Return Delta	#3498db	KPI Supply and Return Delta		✓	Average delta between the supply and return air temp	✓			✓		kpi_SupplyReturnDelta	✓	equip and ahu		30-Aug-2024 Fri 10:41:15PM UTC
KPI Total Sparks for Site	#3498db	KPI Total Sparks for Site		✓	Total Sparks for Site	✓			✓		kpi_TotalSparks	✓	site		3-Jul-2024 Wed 10:55:00PM UTC
KPI VAV Discharge Temp		KPI VAV Discharge Temp		✓	The min and max discharge temp for any vav	✓			✓		kpi_DischargeTemp	✓	vav		3-Jul-2024 Wed 10:55:00PM UTC
KPI Zone Temp Avg.	#e67e22	KPI Zone Temp Avg.		✓	KPI Zone Temp Avg. When Occupied	✓			✓		kpi_ZoneTempAvgWhenOcc	✓	vav		3-Jul-2024 Wed 10:55:00PM UTC
KPI Zone Temp vs SP Delta	#f39c12	KPI Zone Temp vs SP Delta		✓	Zone Temp vs SP Delta	✓			✓		kpi_ZoneTempvsSP	✓	equip and vav		30-Aug-2024 Fri 3:45:43PM UTC
KPI Zone Temp When Occupied	#e67e22	KPI Zone Temp When Occupied		✓	Min and Max Zone Temp When Occupied	✓			✓		kpi_ZoneTempWhenOccupied	✓	vav		3-Jul-2024 Wed 10:55:00PM UTC
Possible Broken CHW Temp Sensor		Possible Broken CHW Temp Sensor			The returning water temperature from the building was 5 degrees below the leaving temperature from the CHWS.	✓	✓				jg_au_brokenDeltaT	✓	equip and (chillerPlant or chilled or equipRef->chillerPlant)		3-Jul-2024 Wed 10:55:00PM UTC
Secondary CHWS Too High	#f39c12	Secondary CHWS Too High		✓	Secondary CHW Leaving Temperature is above 55 °F for longer than 1 hour consecutively.	✓	✓	9			spk_secChwTooHi	✓	equip and (chillerPlant or equipRef->chillerPlant) and not underConstruction		3-Jul-2024 Wed 10:55:00PM UTC
Secondary CHWS Too Low	#f39c12	Secondary CHWS Too Low		✓	Secondary CHW Leaving Temperature is below 40 °F for longer than 1 hour consecutively.	✓	✓	9			spk_secChwTooLow	✓	equip and (chillerPlant or equipRef->chillerPlant) and not underConstruction		3-Jul-2024 Wed 10:55:00PM UTC
VAV Broken Zone Temp Sensor	#f1c40f	VAV Broken Zone Temp Sensor		✓	VAV Space Temp above 90°F or below 50°F for longer than 1 hour, or VAV Space Temp does not change value by more than 0.01°F for longer than 6 hours.	✓	✓	9			jg_vavZoneTempSensorBroken	✓	equip and vav	✓	22-Oct-2024 Tue 1:51:43PM UTC
VAV High Space Temp	#c0392b	VAV High Space Temp		✓	VAV Space Temp above 80 °F (but below 90 °F) for longer than 1 hour between 8am and 5 pm.	✓	✓	8			jg_highSpaceTemp	✓	equip and vav	✓	22-Aug-2024 Thu 4:01:50PM UTC
VAV Low Space Temp	#2980b9	VAV Low Space Temp		✓	VAV Space Temp below 60 °F (but above 50 °F) for longer than 1 hour between 8am and 5 pm.	✓	✓	8			jg_lowSpaceTemp	✓	equip and vav	✓	22-Aug-2024 Thu 4:01:50PM UTC

DISABLED RULES

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id	color	dis	disabled	enabled	help	rule	sparkRule	weight	kpiRule	ruleCost	ruleFunc	ruleInUse	ruleOn	targetRule	mod
AHU Discharge Airflow Performance	#9b59b6	AHU Discharge Airflow Performance	✓		periods when the discharge airflow is outside 15% of its specified setpoint (during occupied times)	✓	✓				spk_dischargeAirflowPerformance(...,false,0.15,false)		ahu		23-Nov-2021 Tue 7:12:22PM UTC
AHU Supply Air Temp Performance	#9b59b6	AHU Supply Air Temp Performance	✓		periods when the AHU supply air temperature is outside 3 degrees of its specified setpoint (during occupied times)	✓	✓				spk_ahuSATperformance(...,false,3.0,false)		ahu and not directZone		23-Nov-2021 Tue 7:12:22PM UTC
Chilled Water Setpoint Deviation		Chilled Water Setpoint Deviation	✓		Water leaving chiller is hotter than the acceptable threshold based on the effective set point.	✓	✓	6			chilledWaterSetPointDeviation		chiller		15-Aug-2022 Mon 4:59:27PM UTC
Chiller Plant Temperature Performance	#9b59b6	Chiller Plant Temperature Performance	✓		periods when the chiller supply water temperature is outside 3 degrees of its specified setpoint (during occupied times)	✓	✓				spk_chillerDischargeTempPerformance(...,false,3.0,false)		chiller and equip and not pump		23-Nov-2021 Tue 7:12:22PM UTC
CHW Waste	#3498db	CHW Waste	✓		periods when the ahu discharge temp is significantly lower than setpoint	✓	✓				spk_cost_chwWaste(...)		ahu and not directZone		23-Nov-2021 Tue 7:12:22PM UTC
Command Mismatch		Command Mismatch	✓		Equip commanded on or off but sensor indicates otherwise for over 10 minutes.	✓	✓				commandMismatch		equip and (chiller or ahu or pump)		29-Jun-2022 Wed 1:57:44AM UTC
Cooling When Econ Available	#2ecc71	Cooling When Econ Available	✓		periods when AHU is using mechanical cooling when it should be economizing	✓	✓				spk_coolingWhenEconAvailable		ahu and not directZone		23-Nov-2021 Tue 7:13:26PM UTC
Damper Always At 100	#c0392b	Damper Always At 100	✓		periods when damper is 100% open for at least 24 hours	✓	✓				spk_valveAlways100(...,24)		damper and unit == "%"		19-Aug-2022 Fri 3:58:58PM UTC
Economizing When Shouldnt	#2ecc71	Economizing When Shouldnt	✓		periods when AHU should not be economizing but is	✓	✓				spk_economizingWhenShouldnt		ahu and not directZone		23-Nov-2021 Tue 7:13:26PM UTC
Fan Signal Mismatch	#c0392b	Fan Signal Mismatch	✓		periods when the fan speed does not reflect the fan command	✓	✓				spk_fanSignalMismatch		ahu		29-Jun-2022 Wed 1:45:53AM UTC
Faulty AHU Discharge Air Static Pressure Sensor	#c0392b	Faulty AHU Discharge Air Static Pressure Sensor	✓		days when the sensor value didn't change at all	✓	✓				spk_faultySensor(...,"discharge and air and pressure and sensor and not alarmPoint",0.1,1day)		ahu and not directZone		19-Aug-2022 Fri 4:02:17PM UTC
Faulty AHU Supply Air Temp Sensor	#c0392b	Faulty AHU Supply Air Temp Sensor	✓		days when the sensor value didn't change at all	✓	✓				spk_faultySensor(...,"discharge and air and temp and sensor",0.1,1day)		ahu and not directZone		30-Nov-2021 Tue 8:18:19PM UTC
Faulty Chiller Discharge Water Temp Sensor	#c0392b	Faulty Chiller Discharge Water Temp Sensor	✓		days when the sensor value didn't change at all	✓	✓				spk_faultySensor(...,"chilled and water and not sp",0.1,1day)		chiller		30-Nov-2021 Tue 8:18:19PM UTC
Faulty Discharge Airflow Sensor	#c0392b	Faulty Discharge Airflow Sensor	✓		days when the sensor value didn't change at all	✓	✓				spk_faultySensor(...,"discharge and air and flow and sensor",0.1,1day)		vav and equip or (ahu and directZone)		19-Aug-2022 Fri 4:02:17PM UTC
Faulty Relative Humidity Sensor	#9b59b6	Faulty Relative Humidity Sensor	✓		Relative Humidity is over 100%	✓	✓				spark_faultyRelHumSensor		equip		19-Aug-2022 Fri 3:59:28PM UTC
Faulty Space Temp Sensor	#c0392b	Faulty Space Temp Sensor	✓		days when the sensor value didn't change at all	✓	✓				spk_faultySensor(...,"zone and air and temp and sensor and not discharge and not offset",0.1,1day)		vav and equip or (ahu and directZone)		24-Jan-2020 Fri 2:29:34PM UTC
Find Nulls	#2c3e50	Find Nulls	✓		Sensor data is null for this period of time.	✓	✓				stdDQFindNulls		point and kind == "Number" and sensor		5-Mar-2020 Thu 1:39:58PM UTC
Find Outliers Based on StdDev	#2c3e50	Find Outliers Based on StdDev	✓		Outliers based on StdDev found.	✓	✓				stdDQFindOutliers		point and kind == "Number" and hisDQAverage and hisDQstdDev		6-Mar-2020 Fri 4:47:20PM UTC
Flatlined Sensor	#c0392b	Flatlined Sensor	✓		periods when the value remained unchanged for at least 24 hours	✓	✓				spk_flatlinedSensor(...,0.1,1day)		point and kind == "Number" and sensor		5-Mar-2020 Thu 1:40:11PM UTC
High Pressure Drop	#8e44ad	High Pressure Drop	✓		High discharge air pressure drop. Greater than 2 inH2O for at least 30 minutes	✓	✓				jg_highDiffPress		ahu		29-Jun-2022 Wed 2:00:06AM UTC
KPI Total Arc Notes	#bdc3c7	KPI Total Arc Notes	✓	✓	Total Arc Notes Made per Site	✓			✓		kpi_TotalArcs	✓	site		26-Aug-2024 Mon 6:21:49PM UTC
KPI Total Energy Used	#1c40f	KPI Total Energy Used	✓	✓	Total Kwh Energy Used	✓			✓		kpi_TotalEnergyUsed	✓	site		26-Aug-2024 Mon 6:21:49PM UTC
Mixed Air Damper Leaking	#c0392b	Mixed Air Damper Leaking	✓		periods when ahu mixed air damper is leaking air	✓	✓				spk_mixedAirDamperLeaking		ahu and not directZone		23-Nov-2021 Tue 7:31:19PM UTC
OA Temp Sensor Needs Calibration		OA Temp Sensor Needs Calibration	✓		Outside Air Temp Sensor is outside of the acceptable deviation when compared against the reported weather service temperatures. Sensor likely needs calibration.	✓	✓				outsideAirTempCalibration		air and temp and sensor and outside		23-Nov-2021 Tue 7:30:34PM UTC
OAT vs Real OAT	#1c40f	OAT vs Real OAT	✓		OAT is more than 5 degrees off real outside air	✓	✓				spark_OATDiff		outside and air and temp		23-Nov-2021 Tue 7:30:34PM UTC
Preheat Waste	#3498db	Preheat Waste	✓		periods when AHU is preheating when it shouldn't be	✓	✓				spk_preheatWaste_func(...)		ahu and not directZone		23-Nov-2021 Tue 7:31:19PM UTC
Short Cycling	#95a5a6	Short Cycling	✓		Point is cycling on/off more often than its min on/off times.	✓	✓				shortCycling		point and kind=="Boot"		19-Aug-2022 Fri 3:58:35PM UTC
Simultaneous Heating and Cooling	#c0392b	Simultaneous Heating and Cooling	✓		periods when the heating and cooling valves are both open	✓	✓				spk_simultaneousHeatingAndCooling		ahu		19-Aug-2022 Fri 3:59:12PM UTC
SM Heating Command	#e67e22	SM Heating Command	✓			✓	✓				heatingCmdSM		equip and vav		29-Jun-2022 Wed 1:59:31AM UTC
TS Gap Too Large	#2c3e50	TS Gap Too Large	✓		There are gaps in your data	✓	✓				stdDQTSGap		point and kind == "Number" and hisDQInterval and hisDQExpire		6-Mar-2020 Fri 2:08:54PM UTC
Valve Always At 100	#c0392b	Valve Always At 100	✓		periods when valve is open 100% for at least 24 hours	✓	✓	6			spk_valveAlways100(...,24h)		(water or preheat or cooling) and valve and unit == "%" and not position		18-Aug-2022 Thu 1:27:28PM UTC
Valve Stuck Open	#27ae60	Valve Stuck Open	✓		Valve status is 0% but there is a 4 degree difference between the return and supply temp	✓	✓				spark_ValveStuckOpen		ahu		18-Aug-2022 Thu 1:27:28PM UTC
VAV Discharge Airflow Performance	#9b59b6	VAV Discharge Airflow Performance	✓		periods when the discharge airflow is outside 15% of its specified setpoint (during occupied times)	✓	✓				spk_dischargeAirflowPerformance(...,false,0.15,false)		vav and equip		23-Nov-2021 Tue 7:12:51PM UTC
VAV Heating Coil Valve Leaking	#c0392b	VAV Heating Coil Valve Leaking	✓		periods when VAV SAT is greater than AHU SAT while the heating coil valve is closed	✓	✓				spk_vavHeatingCoilValveLeaking(...,5.0,0.5h)		vav and equip		19-Aug-2022 Fri 3:59:48PM UTC
VAV Heating Coil Valve Not Opening	#c0392b	VAV Heating Coil Valve Not Opening	✓		periods when the temperature gradient across the heating coil is low while the valve is opened	✓	✓				spk_vavHeatingValveBlocked		vav and equip		19-Aug-2022 Fri 3:59:48PM UTC
VAV Space Temperature Out of Range 65-75	#9b59b6	VAV Space Temperature Out of Range 65-75	✓		periods when the zone temp is outside of 65-75 degrees (during occupied times)	✓	✓				spk_spaceTempOutOfRange		vav and equip or (ahu and directZone)		14-Dec-2021 Tue 1:27:33PM UTC
VAV Space Temperature Outside 4 Degrees of Setpoint	#9b59b6	VAV Space Temperature Outside 4 Degrees of Setpoint	✓		periods when the zone temperature is greater than 4 degrees outside its specified setpoint (during occupied times)	✓	✓				spk_spaceTempPerformance(...,false,4.0,false)		vav and equip or (ahu and directZone)		23-Nov-2021 Tue 3:17:13PM UTC
Zone Temp and Sp Comparison Cool	#3498db	Zone Temp and Sp Comparison Cool	✓		Zone Temp is Off Sp by amount for too long	✓	✓				zoneTempVsSpVariationCooling		vav		15-Aug-2022 Mon 5:01:33PM UTC
Zone Temp and Sp Comparison Heat	#c0392b	Zone Temp and Sp Comparison Heat	✓		Zone Temp is Off Sp by amount for too long	✓	✓				zoneTempVsSpVariationHeating		vav		15-Aug-2022 Mon 5:01:24PM UTC
Zone Temp Out Of Range	#e67e22	Zone Temp Out Of Range	✓		Zone temp is above 110 or below 50	✓	✓				spark_zoneTempOutOfRange		vav		20-Dec-2021 Mon 2:23:27PM UTC

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SECTION 260000 - SUMMARY OF ELECTRICAL WORK

Engineer of Record for electrical work is Matt Johnson, PE, Salas O'Brien, 702 Oberlin Road, Suite 300, Raleigh, NC 27605. 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.



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
260543	Underground Ducts and Raceways for Electrical Systems
260579	Temporary Power and Lighting
260584	Concrete Equipment Pads
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
262713	Electrical Metering Equipment
262726	Wiring Devices
262813	Fuses
265000	Lighting Fixtures
	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
272000	Telephone/Data Systems

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 notify the office of the local Authority Having Jurisdiction, to schedule required inspections. This shall include all inspections of concealed work, interior and exterior, as well as intermediate and final reviews.

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.

1 Framing members shall be designed for their actual loads with allowable stresses set forth in the AISC Specifications
2 and the AISC Code, without excessive deflection and with consideration for rigidity under vibration, in accordance
3 with standard structural practices. Supplementary framing, including design loads, member size and location shall be
4 clearly shown on shop drawings.

5
6 When supplementary framing is indicated, verify that dimensions are suitable and that framing is structurally
7 adequate for the equipment furnished.
8
9

10 **FIRE RATED CONSTRUCTION**

11
12 The fire rating of all floors, ceilings, and partitions shall be maintained. It is the responsibility of this Contractor
13 provide and install any necessary fire resistive components so that the fire integrity of all fire rated structures
14 supporting or containing items required under Divisions 26-28 will not be diminished by the installation of such items.
15 Where device or junction boxes penetrate any fire rated structure, the boxes shall be located in such a manner as not
16 to reduce the fire rating of the structure. Where the Drawings indicate adjacent boxes or devices in rated partitions
17 that would reduce the fire rating of the partition if unprotected, suitable Listed protection methods shall be used to
18 insure the fire rating of the partition will not be decreased by the proximity of other boxes or penetrations.
19

20 Where recessed fixtures are used in fire rated ceilings, suitable construction shall be installed above and around the
21 fixture so that the fire rating of the ceiling is maintained. Refer to Architectural Drawings for fire ratings of ceilings.
22

23 Where recessed panelboards, recessed cabinets, or other items are located in a fire rated partition, suitable
24 construction behind and around the item shall be used to maintain the fire rating of the partition.
25

26 Where fire resistive insulation or other coverings have been applied to a structure or to structural elements to obtain a
27 fire rating and this insulation or covering is removed or otherwise disturbed by the installation of Division 26-28
28 components or other related items, this Contractor shall be responsible for restoring the material to a condition that
29 matches the original fire protective ability.
30

31 Approval must be obtained from the A-E before any boxes, devices, or other components are relocated for the
32 purpose of maintaining fire ratings.
33
34

35 **TESTING LABORATORY APPROVAL**

36
37 All equipment shall be approved for the intended use and shall be Labeled or Listed. In any case where the suitability
38 for a particular application is in question by the A-E or inspection authorities the Contractor shall furnish appropriate
39 standards covering the specific piece of equipment in question. Such standards, if required, shall be requested by
40 the A-E in writing and shall be furnished by the Contractor at no additional cost.
41
42

43 **PERSONNEL GROUND FAULT PROTECTION**

44
45 Personnel ground fault protection is to be provided for certain receptacles as indicated on the Drawings and/or as
46 required by the National Electrical Code. Protection is to be provided by the use of GFCI receptacles; the use of
47 GFCI circuit breakers is not acceptable for the protection of general use receptacles. GFCI receptacles may not be
48 used to protect other downstream non-GFCI receptacles unless specifically indicated on the Drawings.
49

50 If required, use GFCI circuit breakers to protect equipment or dedicated receptacles in locations as indicated on
51 Drawings or panel schedules. GFCI receptacles may not be used to protect downstream circuit components.
52
53

TYPICAL MOUNTING HEIGHTS OF DEVICES

Typical mounting heights for electrical equipment shall be as follows unless otherwise noted on Drawings:

DEVICE	MOUNTING 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.

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 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

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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.

1 Increase Drawing indicated size of conductors for voltage drop as follows:

2
3 Use #10 AWG conductor for 20 Ampere, 120 Volt branch circuit home runs longer than 50 feet, unless
4 otherwise noted on Drawings.

5
6 Use #10 AWG conductor for 20 Ampere, 277 Volt branch circuit home runs longer than 100 feet, unless
7 otherwise noted on Drawings.

8
9 Conduit runs shall contain the number of phase conductors shown on the plans. A dedicated neutral shall be
10 installed for each phase conductor served by single pole, 120 and 277 Volt, 20 Amp circuit breakers. Multi-pole
11 circuit breakers serving 120 and 277 Volt, 20 Amp multi-wire branch circuits with a common neutral shall not be
12 permitted. Conduits runs shall contain related grounding and/or isolated grounding conductors.

13
14 Conduit runs that contain more than one neutral shall have each neutral conductor uniquely identified at
15 each termination, splice and where routed through junction or pull boxes. Neutral conductors containing a
16 factory applied, trace line along the length that matches the color of the associated phase conductor shall be
17 used to meet this requirement. Machine printed labels with the panel and associated circuit number shall
18 also be permitted for identifying neutral conductors. Colored tape and pre-printed tags shall not be
19 acceptable.

20
21 Feeders and/or branch circuits shall not be combined either with each other or one with another into junction
22 boxes, pull boxes, device boxes, manholes, or other common routing unless such routing is specifically
23 indicated on the Drawings.

24
25 Neatly train wiring inside boxes, equipment and panelboards; Avoid bundling conductors with lacing or cable ties so
26 that generated heat may be more easily dissipated.

27
28 Conduit runs indicated on the Drawings as composed of parallel runs of conductors shall be made identical with
29 respect to length, conduit size, wire type, insulation type, routing, and terminations at each end.

30
31 Conductors Shall Be Color Coded as Follows:

32
33 Grounding Conductors: Green

34
35 Isolated Grounding Conductors: Green with yellow tracer

36
37 Grounded Neutral Conductors: White for 120 V systems, gray for 277 V systems

38
39 Ungrounded Phase Conductors for 208Y/120V Systems: Black (phase A), red (phase B), and blue (phase
40 C)

41
42 Ungrounded Phase Conductors for 480Y/277V Systems: Brown (phase A), orange, (phase B) and yellow
43 (phase C)

44
45 Switch Leg Travelers: Violet

46
47 Provide other wire colors as indicated on the Drawings.

48
49 Remarking of insulation colors by use of colored marker tape shall be permitted only as allowed by the NEC.

50
51 Install exposed cables (where permitted) parallel and perpendicular to surfaces, or exposed structural members.
52 Cables shall follow surface contours, where possible.

53
54
55 Completely and thoroughly swab raceway system before installing conductors.

56
57 Branch circuit wiring shall not loop through receptacle terminals, but shall be connected by means of conductor taps
58 joined to branch circuit conductors. At end of run, branch circuit conductors may terminate on receptacle screw
59 terminals. Quick make, clamp, or push-in type terminations may not be used to make connections to devices.

60
61 Position all splices in pull boxes and junction boxes of adequate volume so they are accessible from the removable
62 cover side of the box.

1 Conductors for signal systems shall be continuous (without splice) and shall be terminated on terminal strips or
2 terminate in a manner approved by the system's manufacturer.

3
4 All neutrals and ground wires in panels shall be labeled with cloth wire markers to indicate the circuits being served.

5
6 Pull conductors simultaneously where more than one is being installed in same raceway.

7
8 Use pulling compound or lubricant, where necessary; compound used must not deteriorate conductor or insulation.
9 After conductors have been pulled, clean exposed conductors and surrounding area to remove all evidence of the
10 use of pulling compound.

11
12 Use pulling means including fish tape, cable, rope and basket weave wire/cable grips that will not damage cables or
13 raceway.

14
15 Keep conductor splices to a minimum.

16
17 Install splices and taps that possess equivalent or better mechanical strength and insulation ratings than conductors
18 being spliced.

19
20 Use splice and tap connectors that are compatible with conductor material.

21
22 Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published
23 torque tightening values. Where manufacturer's torque requirements are not indicated, tighten connectors and
24 terminals to comply with tightening torques specified in UL Standard 486A and B.

25 26 27 **WIRING CONNECTIONS AND TERMINATIONS**

28
29 Splices shall be permitted on conductors up to #4 AWG. No splices shall be permitted on conductor #3 AWG and
30 larger without specific approval in writing by the A-E. Splices shall be made in accessible junction boxes; no splices
31 shall be made in conduit bodies.

32
33 Splices, taps, and attachments of fittings and lugs shall be electrically and mechanically secure. Connectors and lugs
34 shall be proper size and labeled as suitable for the number and type of conductors joined.

35
36 Solid conductors, namely those sized #10 and #12 AWG copper shall be spliced or tapped only by the use of Ideal
37 "Wing-Nuts" or "Wire Nuts", Buchanan's "B-Cap" or 3M Co.'s "Scotchlox" connectors. "Sta-Kon" or other permanent
38 type crimp connectors shall not be used.

39
40 Self-stripping electrical pigtail and tap connectors shall not be used.

41
42 Stranded conductors, namely #8 AWG to #4 AWG, shall be spliced or tapped by approved mechanical connectors.
43 Insulation for splices or taps shall be obtained by the use of Listed insulating covers designed for use with the
44 particular connector. Quality of insulation at splices shall equal that of the conductor insulation in terms of
45 temperature resistance, covering ability and durability.

46
47 Conductors, in all cases, shall be continuous from outlet to outlet, and no splicing shall be made except within outlet
48 or junction boxes, troughs, and gutters. No splices shall be permitted in panel enclosures, disconnects or utilization
49 equipment.

50
51 Lugs for conductors #8 through #4 AWG shall be copper, with a direct acting screw. Where permitted, lugs for
52 conductors #3 AWG and larger shall be copper, applied directly to the cable by hydraulic pressure. Lugs shall not be
53 split bolt or screw types.

54 Tape, where used, shall be made using special oil resistant vinyl plastic tape that is Listed, rated 105° C.

55
56 Splices or taps in grounding conductors (where permitted) in sizes #8 AWG and larger shall be by means of
57 exothermic welding and termination shall be by means of approved grounding connectors. As an alternate,
58 connectors using hydraulic compression tools may be used as a contractor selection option. Solder shall not be used
59 as a means of joining grounding conductors.

60
61 Thoroughly clean wires before installing lugs and connectors.

1 Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.

2
3 Terminate spare conductors with electrical tape.

4
5
6 **FIELD QUALITY CONTROL**

7
8 Prior to energizing circuitry, check installed wires and cables with megohm meter to determine insulation resistance
9 levels to insure requirements are fulfilled. Provide additional testing as directed by the A-E in accordance with
10 Section 260800, *TESTING AND PLACING IN SERVICE*.

11
12 Prior to energizing circuitry, test wires and cables for electrical continuity and for short circuits. Verify proper phasing
13 connections.

14
15 Subsequent to wire and cable hook-ups, energize circuitry and demonstrate functioning in accordance with
16 requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

17
18
19 **END OF SECTION 260519**

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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 connections 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.

1 Connect grounding electrode conductors to copper water pipe using a suitable grounding clamp as indicated on
2 drawings. Provide conduit grounding hubs and water pipe ground clamps as required.

3
4 Provide copper grounding conductor from supplemental ground bus bar adjacent service equipment to
5 communications (telephone/data or cable TV) backboards where shown on drawings. Terminate conductor on
6 insulated ground bus bar for use by others.

7
8 Provide an insulated bonding bushing on all panelboard feeders. Terminate feeder equipment grounding conductor
9 by passing the conductor through the terminal of the insulated bonding bushing and then onward to terminate at the
10 panel ground bus.

11
12 Provide an insulated bonding bushing at boxes, enclosures or cabinets with concentric, eccentric or over-sized
13 knockouts. Terminate equipment grounding conductor by passing the conductor through the terminal of the insulated
14 bonding bushing and then onward to terminate at ground bus or lug.

15
16 Connect grounding electrode conductors to 1-inch diameter, or greater, metallic cold water pipe using a suitably sized
17 ground clamp.

18
19 Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with
20 manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing
21 requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to
22 assure permanent and effective grounding.

23
24 Apply corrosion-resistant finish to field-connections, buried metallic grounding and bonding products, and places
25 where factory applied protective coatings have been destroyed.

26
27 Install clamp-on connectors on clean metal contact surfaces to ensure electrical conductivity and circuit integrity.

28
29 Sectionalizing switchgear housing, cable shielding and primary grounding conductors shall be connected to a driven
30 copper ground rod having a maximum resistance of 25 Ohms by means of # 3/0 AWG bare copper stranded
31 conductor.

32
33 Service transformer housing, cable shields, primary and secondary neutrals shall be connected to a driven copper
34 ground having a maximum resistance of 25 Ohms using # 3/0 AWG bare stranded copper conductor. Primary neutral
35 conductor shall be unbroken to transformer primary neutral bushing, and thereafter grounded as indicated on the
36 Drawings.

37 38 39 **FIELD QUALITY CONTROL**

40
41 Upon completion of installation of electrical grounding and bonding systems, test ground resistance with ground
42 resistance tester. Where tests show resistance-to-ground is over 25 Ohms, take appropriate action to reduce
43 resistance to 25 Ohms, or less, by driving additional ground rods; then retest to demonstrate compliance.

44
45 Provide written certified testing report indicating resistance-to-ground value.

46
47
48 **END OF SECTION 260526**

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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 1/4" 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 1/4" 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 1/4" rod sizes, nuts shall be galvanized steel.

Round Steel Rod: Use black steel for 1/2", 3/8" or 1/4" 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

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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 markers, 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 indicated 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 conduit 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.

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:

Panelboards, electrical cabinets and/or enclosures
Switchgear
Disconnect or safety switches
Telephone terminal cabinets
Pushbuttons
Contactors
Transformers
Motor control centers
Transfer switches
Clock/Program master equipment
TV/audio monitoring master stations
Fire alarm master stations
Nurse call systems
Generators

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.

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.

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.

- 1 Use Type 2 fittings for concrete tight connections.
- 2
- 3 Conduit Locknuts: Provide case-hardened steel locknuts for use on threaded raceway.
- 4
- 5 Conduit Bushings:
- 6
- 7 Insulated: Provide Listed and Labeled, threaded, thermosetting plastic bushings at each end of all threaded
- 8 raceway. Provide grounding type if same is indicated elsewhere.
- 9
- 10 Grounding (bonding type): Provide Listed and Labeled, threaded, insulated throat, bonding type bushings.
- 11 Provide steel frame bushings for use on ferrous raceway //and aluminum frame bushings for use with
- 12 aluminum raceway//. Provide bushings with tin-plated copper grounding saddle sized to accept grounding
- 13 conductor size as indicated on the Drawings. Where grounding conductors are oversized, provide separate
- 14 copper grounding lugs that are appropriately sized.
- 15
- 16 Flexible Metal Conduit Fittings: Provide steel conduit fittings for use with flexible steel conduit of threadless hinged
- 17 clamp type. All flexible metal conduit fittings shall be Listed as suitable for grounding.
- 18
- 19 Straight Terminal Connectors: Provide insulated throat type, one piece body, female end with clamp and
- 20 deep slotted machine screw for securing conduit, and male threaded end provided with steel locknut.
- 21
- 22 45° or 90° Terminal Angle Connectors: Provide steel insulated throat type, two-piece body construction with
- 23 removable upper section, female end with clamp and deep slotted machine screw for securing conduit, and
- 24 male threaded end provided with steel locknut.
- 25
- 26 Liquid-Tight Flexible Metal Conduit Fittings: Type 1, Class 3, Style G. Provide cadmium plated, malleable iron
- 27 fittings with compression type steel ferrule and neoprene gasket sealing rings, with insulated throat and steel locknut.
- 28 All liquid tight flexible metal conduit fittings shall be Listed as suitable for grounding.
- 29
- 30 EMT Fittings:
- 31
- 32 EMT Conduit Couplings: Cadmium plated steel, dual compression type with two (2) hexagon compression
- 33 fittings. Fittings that can not be tightened with an open-end wrench of the appropriate size are not
- 34 acceptable.
- 35
- 36 EMT Conduit Connectors: Cadmium plated steel, insulated throat, compression type with hexagon
- 37 compression fitting and steel locknut. Fittings that can not be tightened with an open-end wrench of the
- 38 appropriate size are not acceptable.
- 39
- 40 Unacceptable fitting types: Pot metal, set screw, and indenter type fittings, or connectors that do not have
- 41 insulated throats, are not acceptable for use on this project.
- 42
- 43 Conduit Bodies: Provide galvanized steel conduit bodies of types, shapes and sizes as required to fulfill job and NEC
- 44 requirements. Conduit bodies shall be constructed with threaded conduit entrance ends, removable covers, either
- 45 cast or of galvanized steel, and corrosion-resistant screws.
- 46
- 47 Metallic Conduit, and Tubing Accessories: Provide metallic conduit and tubing accessories of types, sizes, and
- 48 materials, complying with manufacturer's published product information, which mate and match conduit and tubing.
- 49
- 50 PVC Conduit Fittings: NEMA TC 3, mate and match to conduit or tubing type and material.
- 51
- 52 Nonmetallic Conduit, and Tubing Accessories: Provide nonmetallic conduit and tubing accessories of types, sizes,
- 53 and materials, complying with manufacturer's published product information, which mate and match conduit and
- 54 tubing.
- 55
- 56

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 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. Where PVC is permitted it must be installed in accordance with the following:

Where underground raceways turn up into equipment, cabinets or poles, the 90° and/or similar fittings and stub-ups shall be rigid steel conduit grounded by use of bonding bushings connected to the equipment grounding conductor.

Provide minimum 3" concrete encasement for all underground routed PVC conduit. This shall not apply to underground raceways used for branch circuits.

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, $\pm 2^\circ$. 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.

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.

Non-Metallic Raceway:

- Make solvent cemented joints in accordance with recommendations of manufacturer.
- Install PVC raceway in accordance with NEC.

All PVC conduit connections to PVC junction boxes shall be made with listed connectors, approved for the application.

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.

1 Make changes in direction of raceway run by means of proper field bends or with proper fittings, supplied by raceway
2 manufacturer.

3
4 Field-bend conduit with benders designed for purpose so as not to distort nor vary internal diameter.

5
6 Properly support and anchor raceways for their entire length by structural materials. Raceways are not to span any
7 space unsupported for lengths in excess of the maximum support distance as previously specified. Raceways may
8 not be used to support other raceways or other items of equipment.

9
10 Arrange conduit to maintain headroom and present a neat appearance.

11
12 Route exposed conduit and conduit above accessible ceilings parallel and perpendicular to walls and adjacent piping.

13
14 Group raceway in parallel runs where three (3) or more raceway are routed together. Use conduit rack constructed of
15 steel channel with conduit straps or clamps. Provide space for 25% additional conduit.

16
17 Do not fasten and/or hang conduit with wire or perforated pipe straps. Before conductors are pulled, remove all wire
18 used during construction for temporary conduit support.

19
20 Bring conduit to the shoulder of fittings and couplings and fasten securely. All raceway shall be cut to proper length
21 so ends fit accurately in connectors or couplers.

22
23 Use conduit hubs for fastening conduit to cast boxes and for fastening conduit to sheet metal boxes in damp or wet
24 locations.

25
26 Use conduit bodies to make sharp changes in direction, as around beams.

27
28 Use hydraulic one-shot conduit bender for all field bends in conduit. All field made conduit bends shall meet
29 minimum bending radius requirements of the NEC. Bends in metallic conduit shall be made while "cold". Factory
30 made conduit sections may be used in lieu of field made bends for conduit larger than 2".

31
32 Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point.

33
34 Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture.

35
36 Where raceways penetrate walls or partitions separating spaces with differing environmental conditions, such as
37 freezers, coolers and exterior walls, provide an internal seal to prevent condensation within the raceway as it enters
38 the conditioned space.

39
40 Where conduit penetrates fire rated partitions, provide penetration protection in accordance with the UL through-
41 penetration detail indicated on the Drawings for the type of partition and conduit involved. All instructions furnished
42 with firestopping materials shall be followed explicitly.

43
44 Route conduit through roof openings for piping and ductwork where possible; otherwise, route through roof jack with
45 pitch pocket. All pitch pockets shall be absolutely water tight; once conduit has been routed through a pitch pocket
46 the water integrity of the pitch pocket is the responsibility of the Division 26-28 Contractor.

47
48 Combining of circuits into raceway systems other than indicated on Drawings shall not be permitted.

49
50 Bolts, clamps, screws and expansion bolts shall be used in securing conduit, equipment, etc. Holes for lead shields
51 or other anchors shall be the size recommended by the fastener manufacturer and shall be completely covered by
52 the mounted item. Holes used for support of conduit on brick or block walls shall be located in mortar joints where
53 such location is possible.

54
55 Provide nylon pull string in empty conduits where indicated, including conduit placed for telephone and data use.
56 Conduit installed but left empty (with pull string) shall be tested with a ball mandrel. Clear any conduit that rejects ball
57 mandrel. Any costs involved for restoration of conduit and surrounding surfaces to original condition are the
58 responsibility of the Contractor.

59
60
61 **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 3/4" 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 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 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.

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.**

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, $\pm 2^\circ$.

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

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SECTION - 260543 UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL 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 products for electrical related work of sizes, types, ratings, and materials required, whose products have been in satisfactory use in similar service for not less than three (3) years.

Concrete Work Codes and Standards: Comply with governing regulations, and where not otherwise indicated, comply with the following industry standards, whichever is most stringent in its application to work for each instance:

ACI 318 "Building Code Requirements for Reinforced Concrete"

ACI 347 "Recommended Practice for Concrete Formwork"

ACI 304 "Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete"

Concrete Reinforcing Steel Institute, "Manual of Standard Practice"

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.

UNDERGROUND DUCTS

Provide Schedule 40 PVC conduit for secondary power distribution and telecommunications duct banks.

Provide galvanized rigid steel conduit for raceways installed outside of duct banks and where penetrating building exterior walls and turning out of grade.

HAND HOLE

Provide pre-cast polymer concrete hand holes to meet dimension and construction requirements identified on the drawings.

Hand holes shall be accessible on at least 3 sides by trucks, cable reel trailers and other cable pulling equipment.

PART 2 - PRODUCTS

UNDERGROUND DUCTS

PVC conduit shall be Schedule 40, UL Labeled for 90°C cables. Fittings shall be Schedule 40, solvent type, and from the same manufacturer as the conduit.

Galvanized rigid steel conduit shall be hot dipped galvanized inside and outside, in 10 foot lengths and threaded on both ends. Fittings and bushings shall be threaded, cast or malleable iron, and hot dipped galvanized inside and outside.

Marker tape shall be plastic, vinyl, or mylar, 6 inches wide, red for electrical power and orange for telecommunications, and labeled to indicate the type of circuit buried below.

HAND HOLES

Hand holes shall be lightweight polymer concrete, with compressive, flexural and tensile strengths greater than traditional concrete. Enclosures shall be resistant to alkalines, acids, weathering and other forms of deterioration and resist absorption. Hand holes shall be listed by a nationally recognized testing lab for the application for which they are installed.

Hand holes shall be open at bottom and filled with a gravel fill. Provide features as indicated on the drawings.

GROUND

Ground splices and connections at manholes and pull boxes, where required, shall be exothermic welds, or copper (or bronze) compression ground fittings, or bolted compression ground fittings.

MATERIALS OF CONCRETE WORK

Forms for Concrete: Forms for concrete shall be plywood, smooth metal or other smooth panel type material. Forms shall be constructed from sufficiently heavy material to prevent leakage that would be harmful to either structural quality of concrete and reinforced to prevent deflections resulting from pressure of placed concrete. Where concrete is exposed, size forms for minimum joint exposure.

Plywood: PS-1 "BB (Concrete Form) Plywood," Class I Exterior Grade, mill-oiled and edge sealed.

Form Ties: For exposed concrete surfaces, provide snap-off type ties designed to snap off 1-1/2" below surface.

Exposed-Corner Chamfer Strips: Provide wood, metal, plastic or rubber chamfer strips in forms at exposed external corners of concrete work.

Form-Coating Compound: A commercially formulated compound that will prevent bond of concrete to forms shall be used. Provide compound recommended by manufacturer for application indicated, and which will not stain concrete or interfere with moisture curing of concrete or subsequent painting of exposed surfaces.

Reinforcing Bars: Except as otherwise indicated, provide ASTM A 615, deformed, Grade 40 for size numbers 3 through 18; sizes as stated in this Section or shown on Drawings.

Steel Wire: ASTM A 82, plain, cold-drawn.

Welded Wire Fabric: ASTM A 185; sizes and spacings of wires as shown; 6" x 6" x No. 10 x No. 10 where not otherwise indicated.

Reinforcement Supports: Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place. Provide wire bar type supports complying with CRSI recommendations, unless otherwise indicated.

PART 3 - EXECUTION

UNDERGROUND DUCTS

Slope duct banks downward, toward manholes, and away from buildings, a minimum of 4 inches per 100 feet. Duct banks shall not route water from manholes into buildings, or contain traps between manholes where water may accumulate. Where necessary to achieve this between manholes, ducts should be sloped from a high point in the run to drain in both directions. In all cases, slope shall be arranged in a uniform manner at required pitch.

Duct lengths shall be 300 feet or less on straight runs. Longer runs are acceptable only when calculations are completed showing that pulling tensions, and sidewall pressures are not exceeded in the longer pull. Calculations shall be provided to engineer for review and approval prior to installation.

Bends between manholes shall not exceed 180 degrees. When bends are present the maximum length of the duct must be appropriately reduced so the limiting (maximum) pulling tension, and maximum sidewall pressures of the cables are not exceeded.

Directional changes in duct banks shall be made with 20' minimum radius bends. Where this radius cannot be accommodated, perform detailed pulling tension, and sidewall pressure, calculations, to insure compliance with cable manufacturer's recommendations.

Duct banks shall be supported on undisturbed soil or on piers extending down to undisturbed soil.

If the services need to be placed one upon the other the (vertically stacked), the power ducts shall be above the telecommunications ducts.

Duct banks shall include No. 4 steel reinforcing bars placed longitudinally along route on maximum of 4" intervals at 2" above bottom of duct bank. Provide No. 4 steel cross ties at 5 foot intervals along route. Bars shall be made electrically continuous with tie wire throughout length of duct bank.

Prior to concrete encasement, ducts, reinforcing steel and ground wires shall be secured with nonmetallic straps or cable ties to nonmetallic duct spacers at intervals not exceeding 8 feet.

Duct spacers shall be sized for the ducts being held, and shall provide the minimum spacing between ducts required for concrete flow and by the NEC. Duct spacers shall be anchored to the ground using nonmetallic bands and stakes. Separators shall be spaced close enough to prevent sagging and deforming of ducts. Separators to the earth and to ducts should be secured to prevent floating during placement of concrete. Steel or tie wires should not be used in such a way as to form conductive or magnetic loops around ducts or duct groups.

Provide bell end fittings on ducts where the ducts enter manholes or buildings. Note that the use of a coupling on the end of a length of PVC pipe, is not the equivalent of a bell end fitting - only true 'bell end fitting' shall be used to meet this requirement. The duct(s) and associated bell end fittings shall be securely grouted into the wall of the manhole.

Seal all ducts at terminations, using sealing compound for ducts with cables and plugs for spares, to withstand 15 psi minimum hydrostatic pressure.

Where duct banks enter manholes or buildings, they shall be core-drilled into the wall. Individual openings shall be made completely water tight prior backfilling.

Place marker tape approximately 12 inches below finished grade, directly above duct banks for the entire length of the duct run.

Contractor shall clean all ducts, using a flexible mandrel and a stiff bristled brush. Leave a pulling string in the duct when cleanout is complete. Provide waterproof marking cord (130-pound tensile test and marked at least every foot), equivalent to Greenlee No. 435, in all ducts, including spares.

1 **HAND HOLES**

2
3 Hand holes shall be installed on a base of pea gravel or NCDOT Class II sand at least 12 inches deep. Refer to
4 drawings for requirements for placing concrete around enclosure.
5

6
7 **CONCRETE REINFORCEMENT**

8
9 General: Comply with requirements and recommendations of specified standards, including "Placing Reinforcing
10 Bars" by CRSI. Place bars where indicated and support to prevent displacement during concrete placement, using
11 appropriate reinforcement supports, properly spaced and wire tied to reinforcing bars.
12

13 Place reinforcement to obtain at least minimum recommended coverage for concrete protection. Set wire ties so
14 ends are directed into concrete, not toward exposed concrete surfaces.
15

16 Install welded wire fabric in as long lengths as practicable. Lap adjoining pieces at least one full mesh and lace
17 splices with 16-gage wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.
18

19 Clean reinforcement of loose rust and mill scale, earth, ice, and other materials which would reduce bond with
20 concrete.
21

22
23 **PLACING CONCRETE**

24
25 Strength-Class Applications: Comply with compressive-strength- classes shown on Drawings for each unit of
26 electrical concrete work or, if not shown, comply with following general application requirements.
27

28 Backfill: Provide backfill class (lean concrete).
29

30 Electrical Equipment Pads: Pads shall be a minimum of 4 inches thick. Thickness shall be greater where
31 identified on the Drawings. Concrete shall achieve minimum strength of 3000 psi at 28 days.
32

33 Concrete Encasement: Duct banks shall have a minimum of 3 inches of concrete cover on all sides.
34 Concrete shall achieve minimum strength of 3000 psi at 28 days.
35

36 Deposit concrete continuously or in layers of thickness that will result in no concrete placed on concrete that has
37 hardened sufficiently to cause formation of seams or planes of weakness within section. If a section cannot be
38 placed continuously, provide construction joints as specified. Deposit concrete as nearly as practicable in its final
39 location, so as to avoid segregation due to re-handling or flowing.
40

41 Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping.
42 Use equipment and procedures complying with recommended practices of ACI 309; eliminate voids in work.
43

44 Hot Weather Placement: Comply with ACI 305 when hot weather conditions could impair work. Maintain concrete
45 temperature below 90° F at time of placement, by cooling ingredients. Mixing water may be chilled, or chopped ice
46 may be used to control concrete temperature, provided water equivalent of ice is included in calculating compliance
47 with water/cement ration limitations. Cover reinforcing steel with water-soaked burlap as necessary to ensure that
48 steel temperature will not exceed ambient air temperature immediately before embedment in concrete.
49

50
51 **END OF SECTION 260543**

SECTION 260579 - TEMPORARY POWER AND LIGHTING

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

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.

SCOPE OF WORK

Provide complete jobsite temporary electrical power service equipment, distribution panels, distribution wiring, luminaries, and connection devices as described in this section of the project specifications.

Cost of electrical energy for the duration of the project shall be the responsibility of the General Contractor.

PART 2 - PRODUCTS

Products shall be new and as specified in this Division unless reuse of existing facilities is specifically indicated on the Drawings.

PART 3 - EXECUTION

Provide temporary electrical service and service equipment required for construction activities of all project divisions. Provide connection of the electrical service to the electrical utility. All fees and permits for the temporary electrical service are the responsibility of the Contractor.

Provide Temporary Lighting: Provide temporary lighting for general illumination and task illumination for the General Contractor, other prime contractors, and for all sub-contractors for the duration of the construction. Lighting levels provided are to be in compliance with applicable workplace standards.

Complaints concerning lighting levels and/or lighting quality in a specific area or areas of the project will be reviewed by the A-E. If directed by the A-E, the Contractor shall provide additional luminaries and/or additional distribution wiring required under this section at no additional cost.

All temporary lighting shall be supplied by circuits protected by ground fault circuit breakers. All temporary lighting shall be in accordance with NFPA-70 Article 590.

Provide Temporary Power Distribution: Provide temporary power distribution and connection devices for use by General Contractor, other prime contractors, and for all sub-contractors for the duration of the construction. Provide temporary power distribution and connection devices for the testing of selected items of utilization equipment as required by General Contractor, other prime contractors, or any sub-contractor.

Complaints concerning power distribution or devices available in a specific area or areas of the project will be reviewed by the A-E. If directed by the A-E, the Contractor shall provide additional power distribution or connection devices required under this section at no additional cost.

- 1 All temporary branch circuits shall be supplied by circuits protected by ground fault circuit breakers. All temporary
- 2 branch circuits shall be in accordance with NFPA-70 Article 590.
- 3
- 4 Remove all Temporary Wiring: At the conclusion of construction activities remove all wiring, both exposed and
- 5 concealed, used for temporary lighting and power distribution.
- 6
- 7
- 8 **END OF SECTION 260579**

SECTION 260584 – CONCRETE EQUIPMENT PADS

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 products for electrical related work of sizes, types, ratings, and materials required, whose products have been in satisfactory use in similar service for not less than three (3) years.

Concrete Work Codes and Standards: Comply with governing regulations, and where not otherwise indicated, comply with the following industry standards, whichever is most stringent in its application to work for each instance:

ACI 347 "Recommended Practice for Concrete Formwork"

ACI 304 "Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete"

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.

PROJECT CONDITIONS

Protect property from any and all damage that might result from concrete forming and placement.

PART 2 - PRODUCTS

MATERIALS OF CONCRETE WORK

Form Materials and Construction:

Forms for Exposed Concrete: Forms for exposed concrete shall be plywood, smooth metal or other smooth panel type material, sized for minimum joint exposure, and reinforced to prevent visible deflections resulting from pressure of placed concrete. Forms shall be constructed from sufficiently heavy material to prevent leakage that would be harmful to either structural or visual quality of concrete.

Exposed-Corner Chamfer Strips: Provide wood, metal, plastic or rubber chamfer strips in forms at exposed external corners of concrete work.

Form-Coating Compound: A commercially formulated compound that will prevent bond of concrete to forms shall be used. Provide compound recommended by manufacturer for application indicated, and which will not stain concrete or interfere with moisture curing of concrete or subsequent painting of exposed surfaces.

CONCRETE MIXING

Ready-Mix Concrete: Comply with requirements of ASTM C 94, except as otherwise indicated.

Delete references for allowing additional water to be added to batch for material with insufficient slump.
Addition of water to batch will not be permitted.

During hot weather, or under conditions contributing to rapid setting of concrete, mix each load for shorter period of time than specified in ASTM C 94. When air temperature is between 85° and 90° F, reduce mixing and delivery time from 90 to 75 minutes, and when air temperature is above 90° F, reduce mixing and delivery time to 60 minutes.

CLEAN-UP

Upon completion of concrete work, clean excess concrete from adjacent areas and surfaces. Remove excess concrete by proper methods of washing or scraping, using care not to scratch or otherwise damage finished surfaces.

PART 3 - EXECUTION

ACCESS TO ELECTRICAL WORK

Coordinate with other work, including substrate construction work, as necessary to interface installation of electrical equipment with other work.

Provide adequate access to all electrical equipment in accordance with NEC.

INSTALLATION OF CONCRETE WORK

Formwork:

General: Design, construct and maintain formwork to support vertical and lateral loads including pressure of cast-in-place concrete. Construct formwork so that formed concrete will be required size and shape and in required location. Construct with joints that will not leak cement paste. Form sides and bottoms of concrete work, except where clearly indicated to be cast directly in an excavation or against other construction, or on grade or prepared subgrade. Design and construct forms for easy removal without damage to concrete and other work.

Install chamfer strips at external corners of exposed concrete work.

Form Coating: Coat concrete-contact surfaces of forms to be removed. Apply form-coating compound before reinforcement is placed. Apply in accordance with manufacturer's instructions and remove excess compound and spillage.

Cleaning and Tightening: Clean forms and adjacent surfaces to receive concrete just before concrete is placed. Retighten forms promptly during concrete placement where required to eliminate leakage of cement paste.

Placing Concrete:

Wet wooden forms which have been coated with compound, immediately before placing concrete, and remove excess water from forms.

Strength-Class Applications: Comply with compressive-strength- classes shown on Drawings for each unit of electrical concrete work or, if not shown, comply with following general application requirements.

Electrical Equipment Pads: Pads shall be a minimum of 4 inches thick. Thickness shall be greater where identified on the Drawings. Concrete shall achieve minimum strength of 3000 psi at 28 days.

Deposit concrete continuously or in layers of thickness that will result in no concrete placed on concrete that has hardened sufficiently to cause formation of seams or planes of weakness within section. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete as nearly as practicable in its final location, so as to avoid segregation due to re-handling or flowing.

Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures complying with recommended practices of ACI 309; eliminate voids in work.

Bring horizontal surfaces to correct level with straight edge and strike off. Use bull floats or darbies to smooth surface, leaving it free of humps and hollows.

Finishing Horizontal Surfaces: Float and trowel horizontal (top) surfaces to level, smooth, uniform textured, dense finish, where surface is to remain exposed or receive a coating, membrane or other thin-set applied finish. Otherwise, leave struckoff surface undisturbed except scratch surfaces that are to receive concrete or mortar topping or setting bed by raking with a stiff broom.

Form Removal and Surface Repairs:

Form Removal: Remove forms as soon as concrete has set and gained sufficient strength to ensure that neither removal of forms nor stress introduced by removal of support contributed by forms will result in damage to concrete.

Retain forms on vertical surfaces of concrete for not less than 3 days after concrete is placed.

Unexposed Surfaces: Repair significantly damaged and honeycombed areas, and remove major projections and fins where forms have been removed.

Exposed Surfaces: On formed surfaces that are to be exposed, including those to be coated or covered with a membrane or other thin-set applied finish, repair and patch form-tie holes and damaged and honeycombed areas, filling voids with grout and completely removing fins and other projections.

CONCRETE CURING AND PROTECTION

General: Protect freshly placed concrete from drying and excessively cold and hot temperatures, and maintain in moist condition at relatively constant temperature for period of time necessary for hydration of cement, proper hardening, and achievement of strength requirements as specified.

END OF SECTION 260584

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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.

1 Provide flexible connections to equipment as follows:

2
3 Provide Flexible Metal Conduit (FMC) for connection of electrical equipment where subject to movement and
4 vibration or as otherwise required by the Specifications or on the Drawings.

5
6 Provide metal Liquidtight Flexible Metal Conduit (LFMC) for equipment in exterior locations, wet locations, or
7 in other locations where so indicated on the Drawings.

8
9 Fasten identification markers to each electrical power supply wire/cable conductor that indicates their voltage, phase
10 and feeder number in accordance with Section 260533, *ELECTRICAL IDENTIFICATION*. Affix markers on each
11 terminal conductor, as close as possible to the point of connection.

12
13
14 **FIELD QUALITY CONTROL**

15
16 Upon completion of installation of electrical connections, and after circuitry has been energized with rated power
17 source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of
18 rotation of each motor fulfills requirement. Correct malfunctioning units at site, then retest to demonstrate
19 compliance.

20
21
22 **END OF SECTION 260593**

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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.

All references to commissioning in this section shall be the responsibility of the Contractor.

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-Contractor Representative

"

END OF SECTION 260596

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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:

- Busways
- Cable Tests
 - Low Voltage (≤ 600 Volt)
- Grounding
- Ground fault operation and coordination
- Metering
- Overcurrent devices
- Rotating Equipment
- Service Equipment Tests
- Switchboards and Panelboards (≤ 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.

1 **GROUNDING**

2
3 Resistance: Measure the resistance (relative to earth) of each electrical equipment ground brought up from each
4 grounding electrode, made electrode (rod), and the underground grid.

5
6 Do not measure outside ground rod and ground grid resistances to earth during unusually wet weather.

7
8 The Test Record Shall Include the Following:

9
10 Identification of the ground point where the test is performed.

11
12 Value of resistances relative to earth.

13
14 Test ground resistance with tester equivalent to Fluke 1625. Test arrangement shall be based on a three point, fall of
15 potential test. Two field installed stakes used for the test shall be placed to form a line with the driven grounding
16 electrode and separated at intervals of 60 feet. Where tests show resistance-to-ground is over 25 Ohms, take
17 appropriate action to reduce resistance to 25 Ohms, or less, by driving additional ground rods; then retest to
18 demonstrate compliance.

19
20
21 **GROUND FAULT OPERATION AND COORDINATION**

22
23 Upon selection of the product line and approval of the equipment submittal package, the engineer shall conduct a
24 coordination study to determine appropriate settings for adjustable circuit breakers. The ground fault protection on
25 the circuit breakers shall be set in accordance with information provided by the engineer.

26
27 Performance Testing of Time-Current Functions: For services 1,000 amperes and larger, the following tests should
28 be performed on the service circuit breakers and the distribution circuit breakers. Using circuit breaker test set, set
29 and field test time-current trip functions for new circuit breakers to verify operation in accordance with the circuit
30 breaker settings provided by the engineer. Testing shall be performed by a qualified factory technician at the job site.
31 All readings shall be tabulated:

32
33 Ground fault tripping tolerance (within 20% of UL requirements).

34
35 Trip time in seconds.

36
37 Where additional testing of existing equipment is indicated on the drawings, use circuit breaker test set to set and
38 field test time-current trip functions for existing circuit breakers to verify operation in accordance with the circuit
39 breaker settings provided by the engineer.

40
41
42 **METERING**

43
44 General: Test all meter functions to verify the accuracy of the readings for each meter and display instrument
45 provided as a part of the project. Where meters are provided with selector switches, all functions shall be tested for
46 each switch position and/or for each combination of switch positions.

47 The Test Record Shall Include the Following:

48
49 Complete identification of the meter and, as appropriate, switch function selected.

50
51 Meter reading as compared with the reading of the test instrument. For meters that display harmonic
52 functions provide the displayed values for each harmonic.

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.

ROTATING EQUIPMENT

During installation, inspect all rotating equipment for damage, moisture, alignment, proper lubrication, oil leaks, phase identification and cleanliness. Check proper rotation. Check and record motor speed (speeds for multi-speed motors).

Perform a megger test on all rotating equipment with the windings at ambient temperature. Dry and retest any machine not passing this test until it either passes or is found unsatisfactory.

For three phase motors, apply megger tests between all phases tied together and ground.

Maintain megger tests for one (1) minute or until the reading maintains a constant value for 15 seconds.

Final acceptance of rotating equipment will be made after the equipment is successfully energized during operational tests. Tests with each machine mechanically uncoupled (where reverse rotation could damage equipment) shall prove proper rotation, lubrication and alignment. The machine under test shall not have an excessive vibration.

The Test Record Shall Include the Following:

Complete identification of item of rotating equipment.

Values of megger tests.

Rotational speed of the equipment under test.

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 ($M\Omega$).

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.

DOCUMENTATION

All tests specified shall be completely documented indicating time of day, date, temperature and all pertinent test information.

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.

TEST RESULTS

The Contractor shall send a letter to the engineer, with a copy to the State Construction Office (SCO) official project observer, certifying that the above testing has been performed. This shall be done at least four (4) days prior to final inspection.

Final testing reports are to be available at the SCO final inspection.

At final inspection, the Contractor shall furnish instruments as required to demonstrate to the A-E and to the SCO representative that all testing requirements have been satisfied. All measurement instruments, labor, and materials associated with the testing, verification, and demonstration of results shall be provided without additional cost. The contractor shall provide ladders, hand tools, digital multimeters, meggers, two-way radios and other specific items required by the Engineer for the final inspection.

END OF SECTION 260800

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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 mechanical 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.

1 **CLEANING**

2
3 Cleaning: Clean equipment and devices internally and externally using methods and materials recommended by
4 manufacturers, and repair damaged finishes.
5

6
7 **TESTING & DOCUMENTATION**

8
9 Provide a minimum 90 minute battery test for each inverter under complete load. Provide documentation of output
10 voltage at unit at beginning of the test and at the end of the 90 minute period. All product features shall be verified by
11 the Contractor and demonstrated for the engineer.
12

13 Provide verification of proper installation of components and systems as outlined in Section 260596, Lighting
14 Systems Commissioning. Provide all necessary components to properly demonstrate operation of equipment to
15 engineer.
16

17
18 **OPERATIONS AND MAINTENANCE MANUAL**

19
20 Manuals shall include product data for all installed products that identifies all selected options for each component of
21 lighting controls system.
22

23 Identify manufacturer's requirements and recommendations for routine maintenance actions, recalibration and
24 cleaning. Identify schedule for items above.
25

26 Provide a narrative of the system operation, specific to the installation, including the actual set points.
27

28
29 **TRAINING**

30
31 Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:
32

33 Train Owner's maintenance personnel on troubleshooting, servicing, adjusting, and preventive maintenance. Provide
34 a minimum of 16 hours of training.
35

36 Training Aid: Use the approved final version of maintenance manuals as a training aid.
37

38 Schedule training with Owner, through A-E, with at least seven days' advance notice.
39
40

41 **WARRANTY PERIOD**

42
43 Warranty period for occupancy sensors shall be one year, beginning upon acceptance of the installation by the
44 Owner. Include up to three site visits within the first year, upon request by the Owner, to adjust light levels, make
45 program changes, and adjust sensors and controls to suit actual conditions.
46

47 Warranty period for branch circuit inverters shall be full 3 years for defects in workmanship, battery and materials.
48 Battery shall have an additional 7 year prorated warranty.
49
50

51 **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.

1 Relay panels shall provide a mounting bracket for the addition of group relay controllers and time clocks, as required
2 for the location. These control devices shall be totally compatible with the manual operation of the low voltage
3 switches.

4
5 Modular relay panels shall be UL listed and consist of the following:

6
7 Tub: Empty NEMA 1 enclosure sized to accept an interior with 48 relays.

8
9 Interior: Bracket and circuit board backplane. Interiors shall be sized to accept 24 relays.

10
11 Relays: Lighting control relays shall be suitable for all types of loads up to 20 Amperes. Load contacts shall
12 withstand 1500 amps of fault current for up to 20 mS. Relays shall be momentary-pulsed mechanically latching
13 contactors rated at 20 amps, 120-277 VAC. Relays shall attach to the panel interior by a single plug-in connector.
14 Each relay shall be capable of direct on/off control by low voltage (intelligent) switch. A means to override this feature
15 shall be provided at the panel. System to have means to provide alternate inputs (building automation system, time
16 clock, photocell, occupancy), to relay groups/zones. Provide additional modules, power supplies, controllers, and
17 interfaces to provide this function as indicated on plans. System shall be capable of accepting inputs from devices of
18 other manufactures via contact closure.

19
20 Master stations shall provide a manual means to activate/deactivate all zones as indicated on plans. Systems shall
21 have the capability of interfacing with a Windows based graphical user based application or a touch screen controller.

22
23 System shall have a means to allow offsite control via a modem or TCP/ICP protocol.

24
25 System shall have a flash waving feature to notify user of shutdown prior to deactivating zone.

26
27 System shall have a means to sense loss of power and automatically activate identified emergency circuits served by
28 auxiliary power sources (Generators, UPS's or Inverters).

29
30 Power Supply: Panels shall include a transformer assembly providing power to relays. Provide additional
31 transformers for associated low voltage switches and timers. Transformers include internal over current protection
32 with automatic reset and metal oxide varistor protection against powerline spikes. 120 VAC, 50/60 Hz. +/- 10%.

33
34 Cover: Surface with captive screws in a hinged, lockable configuration. A wiring schedule directory card shall be
35 affixed to the cover's back to allow identification of circuits/relays/loads controlled when the door is open.

36
37 Switch Stations: Remote switch stations shall consist of two wire relay switches with LED indicating lamps to indicate
38 ON and OFF states. Switch construction shall permit labels to be placed beneath cover to describe function.
39 Construction shall be modular to permit multiple switches in a single yolk and gangable. Switches at each remote
40 location shall be grouped into a single backbox with a common factory stainless steel cover.

41
42 Master Stations: Master stations shall consist of two wire relay switches for each relay lighting group specified. Each
43 relay switch shall have LED indicating lamps to indicate ON and OFF states. Switch construction shall permit labels
44 to be placed beneath cover to describe function. Construction shall be modular to permit multiple switches in a single
45 yolk and gangable. Switches at the master station shall be grouped into a single backbox with a common factory
46 stainless steel cover

47
48 Relay Group Controller: Lighting relay groups, as indicated on the Drawings, shall be controlled collectively by a relay
49 group controller. Controllers shall be solid state and have up to 24 relay outputs for controlling individual lighting
50 branch circuits. Controllers shall be controlled by a relay or by time clock. Controller shall include control for (4)
51 distinct activation and deactivation of zone events.

52
53 Momentary Override Switch: Provide momentary override switches as indicated on the Drawings. Switches shall be
54 located to provide for the override specific lighting relay control groups during unoccupied hours. The relay panel
55 shall be programmed to respond to override switches by overriding loads over a range of time from 5 minutes up to 2
56 hours.

57
58 Time Clock: Clocks providing automatic control of lighting relay groups shall have a minimum of 8 outputs that are
59 individually programmable. Clocks shall have astronomical control permit 20 distinct holiday schedules per calendar
60 year. Program memory shall be indefinite for all outputs and power loss protection shall maintain accurate time at the
61 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.

1 Provide a narrative of the system operation, specific to the installation, including the actual set points.

2
3
4 **TRAINING**

5
6 Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:

7
8 Train Owner's maintenance personnel on troubleshooting, servicing, adjusting, and preventive maintenance. Provide
9 a minimum of 16 hours of training.

10
11 Training Aid: Use the approved final version of maintenance manuals as a training aid.

12
13 Schedule training with Owner, through A-E, with at least seven days' advance notice.

14
15
16 **WARRANTY PERIOD**

17
18 Warranty period for relay panels shall be one year, beginning upon acceptance of the installation by the Owner.
19 Include up to two site visits within the first year, upon request by the Owner, to adjust programming and controls to
20 suit actual conditions.

21
22
23 **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 75°C, hot-spot and average temperature rise above 40°C 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°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°C when transformer is operating continuously at rated load with ambient temperature of 40°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.

1 Finishes: Coat interior and exterior surfaces of transformer, including bolted joints, with manufacturer's standard light
2 gray outdoor enamel over cleaned and phosphatized steel enclosure.
3

4
5 **PART 3 - EXECUTION**
6

7
8 **INSPECTION**
9

10 Installer must examine area and conditions under which transformer and ancillary equipment are to be installed, and
11 notify A-E in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until
12 unsatisfactory conditions have been corrected.
13

14
15 **INSTALLATION OF TRANSFORMERS**
16

17 Install transformers as indicated, complying with manufacturer's written instructions, applicable requirements of NEC,
18 NESC, NEMA, ANSI and IEEE standards, and in accordance with recognized industry practices to ensure that
19 products fulfill requirements.
20

21 Coordinate transformer installation work with electrical raceway and wire/cable work, as necessary for proper
22 interface.
23

24 Install units on vibration mounts; comply with manufacturer's indicated installation method, if any.
25

26 Connect transformer units to electrical wiring system with liquidtight flexible conduit; comply with requirements of
27 other Division 26-28 sections.
28

29 Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's
30 published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not
31 indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std. 486A and B.
32

33 Equipment/System Identification: Provide equipment identification nameplates complying with Section 260533,
34 *ELECTRICAL IDENTIFICATION*.
35

36
37 **GROUNDING**
38

39 Provide equipment grounding connections for transformers as indicated, including ground connection to water pipe
40 and ground connection to grounding rod. Tighten connections to comply with tightening torques specified in UL Std.
41 486A to assure permanent and effective grounding.
42

43
44 **TESTING**
45

46 Prior to energizing of transformer, check all accessible connections for compliance with manufacturer's torque
47 tightening specifications.
48

49 Prior to energizing, check circuitry for electrical continuity, and for short-circuits.
50

51 Upon completion of installation of transformer, energize primary circuitry at rated voltage and frequency from normal
52 power source, and test transformer, including, but not limited to, audible sound levels, to demonstrate capability and
53 compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate
54 compliance; otherwise, remove and replace with new unit or components, and proceed with retesting.
55

56
57 **END OF SECTION 262200**

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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 I²t 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-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 Std 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 Std 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 262713 – ELECTRICAL METERING 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 metering equipment, 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 the following manufacturers:

Electro-Industries
Square D
Cutler Hammer
General Electric
Siemens

Codes and Standards:

Electrical Code Compliance: Comply with applicable State code requirements of the authority having jurisdiction and appropriate NEC Article as applicable to the indicated equipment.

Testing Laboratory Compliance: Comply with applicable requirements of relevant UL standards. Provide equipment that is Listed and Labeled. Provide equipment with surge withstand ability conforming to IEEE C37.90.1.

Special-Use Markings: Provide equipment, constructed for special use, with appropriate Listed marks that indicate suitability for special type of use or application indicated.

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 electrical metering equipment. Submit published documents for incidental metering equipment items including interconnection and connectivity cabling, display units, sensors, current and voltage transformers, and software packages.

Shop Drawings: Submit shop drawings showing equipment, device locations, and connecting wiring of entire electrical metering system. Shop drawings shall show connections to the Owner's LAN or intranet system where such connections are depicted on the Drawings. Copies of Project Construction Documents or details therefrom may not be a part of the shop drawing submittal.

Installation Instructions: Submit Manufacturer's detailed installation instructions for all electrical metering system components.

PART 2 - PRODUCTS

EQUIPMENT

General: Except as otherwise indicated, provide the specific item of equipment as described within the notes, reference or equipment schedules on the Drawings. Equipment shall be manufactured by the indicated manufacturer unless specific approval is obtained in writing from the Engineer.

SWITCHBOARD OR MAIN DISTRIBUTION PANELBOARD POWER METERS

The Meter shall accept current inputs from standard instrument transformers (5A secondary current transformers).
The meter shall accept a voltage metering range of up to 250 volts, phase to phase.

Meter shall be multi-function 3 phase, solid-state, socket-mount design.

1. Meter shall be capable of connection to three-phase, four-wire or three-phase, three-wire circuits.
2. Voltage sensing provisions shall be connected to a dedicated, 3 pole circuit breaker in main distribution panelboards.
3. Voltage sensing provisions shall be connected to a dedicated leads with fused protection in switchboards.
4. Meter shall support meter form factor 9S.
5. Meter enclosure shall be ringless type.

The Meter shall have the following ratings and specifications:

The Meter shall withstand 200% rated current continuously. It shall withstand 10 times rated current for at least 3 seconds without damage.

Voltage inputs shall be optically isolated to 2500 volts DC.

The Meter shall be user programmable to any CT ratio. Programming data shall be password protected. DIP switches or designs that offer only fixed ratios shall not be acceptable.

Voltage and current connections shall be segregated from each other to provide safe connections.

The Meter shall have an accuracy of $\pm 0.15\%$ or better for Volts and Amps, and $\pm 0.2\%$ for Watts.

The Meter shall provide true RMS measurements of voltage, phase to neutral, and phase to phase; current, per phase and neutral; real power, reactive power, apparent power, power factor and frequency.

Voltages and currents shall be sampled at a minimum rate of 128 samples per cycle.

The Meter must be capable of providing readings for both instantaneous and average readings.

The Meter must also be capable of providing all single phase real, apparent, reactive power and power factor values.

The Meter shall record and store total bi-directional energy. It shall include separate registers for positive and negative energy.

The Meter shall record and store total bi-directional accumulated energy, total accumulated apparent energy, and total accumulated reactive energy.

The Meter shall meter max/min average demand values for all current and power readings. The demand interval shall be user programmable.

Maximum and minimum values shall be stored with a date/time stamp.

PANELBOARD POWER METERS

The Meter shall accept current inputs from standard instrument transformers (5A secondary current transformers).
The meter shall accept a voltage metering range of up to 250 volts, phase to phase.

Meter shall be multi-function 3 phase, solid-state design, suitable for mounting in separate enclosure at panelboards.

1. Meter shall be capable of connection to three-phase, four-wire or three-phase, three-wire circuits.
2. Voltage sensing provisions shall be connected to a dedicated, 3 pole circuit breaker in panelboards.

The Meter shall have the following ratings and specifications:

The Meter shall withstand 100 amps for at least 10 seconds without damage.

Voltage inputs shall be galvanically isolated to 2500 volts DC.

The Meter shall be user programmable to any CT ratio. Programming data shall be password protected. DIP switches or designs that offer only fixed ratios shall not be acceptable.

Voltage and current connections shall be segregated from each other to provide safe connections.

The Meter shall have an accuracy of $\pm 0.2\%$ or better for Volts and Amps and Watts.

The Meter shall provide true RMS measurements of voltage, phase to neutral, and phase to phase; current, per phase and neutral; real power, reactive power, apparent power, power factor and frequency.

PART 3 - EXECUTION

EXAMINATION

Examine areas and conditions under which metering systems are to be installed, and notify Engineer in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

INSTALLATION OF METERING EQUIPMENT

General: Install metering equipment 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.

Provide properly wired electrical connections for all equipment.

Provide test switches for locations where meters are installed at switchboards. CT's shall be provided as part of the switchboard package. Test switches shall be installed in a separate enclosure, between the CT's and the meter base and permit single point field connection of meter leads at the test switches.

Provide CT's and plated test switches for locations where meters are installed at main distribution panelboards. CT's shall be XX:5 Amp ratio based on specific panelboard application, where XX represents the panelboard rating. CT's shall be installed in the panelboard in a manner that avoids interference with branch wiring. Test switches shall be installed in a separate enclosure, between the CT's and the meter base and permit single point field connection of meter leads at the test switches.

Provide CT's and plated test switches for locations where meters are installed at sub panelboards (lighting and mechanical). CT's shall be XX:5 Amp, based on specific panelboard application, where XX represents the panelboard rating. CT's shall be installed in the panelboard in a manner that avoids interference with branch wiring. Test switches shall be installed in a separate enclosure along with meter, arranged to permit single point field connection of meter leads at the test switches.

GROUNDING

Provide equipment grounding connections for equipment as indicated. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds. All equipment shall be grounded with an insulated grounding conductor routed with the equipment feeder. Grounding conductor shall be bonded to the equipment grounding bus.

FIELD QUALITY CONTROL

Prior to energizing electrical circuitry, check all accessible connections to manufacturer's tightening torque specifications.

Prior to energizing equipment, 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 equipment for electrical continuity of internal circuits, and for short-circuits.

METERING EQUIPMENT START-UP

Where such services are available from the manufacturer, factory personnel shall start-up and test all equipment. Such start-up services shall be properly coordinated with other construction activities and shall be accomplished in a timely manner. Factory start-up services shall be provided at no additional cost to the Owner.

ADJUSTMENTS

Any necessary adjustments to equipment shall be made by factory trained personnel at the time of start-up.

CLEANING

Touch-up scratched or marred surfaces to match original finishes.

DEMONSTRATION

Subsequent to wire and cable hookups, energize metering equipment and demonstrate functioning in accordance with requirements. Verify that metering data is available by access to the Owner's LAN or intranet system. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

WARRANTY

Provide a complete unlimited one year factory warranty on all equipment installed under this Section. Warranty time period shall begin when each item of equipment is accepted by the Owner.

END OF SECTION 262713

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.

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 wiper 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 wiper 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 wiper 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.

Miscellaneous Features:

Provide the following additional receptacle features where such is required by code or indicated on the drawings:

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.

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 stainless steel (Type 302) 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.

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 Std's 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 262813 - FUSES

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.

QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacture of fuses of types and sizes required, whose products are Listed and Labeled.

Codes and Standards:

Testing Laboratory Compliance: Comply with applicable provisions of UL 198D, "High-Interrupting-Capacity Class K Fuses." Provide overcurrent protective devices that are Listed and Labeled.

NEC Compliance: Comply with NEC as applicable to construction and installation of fuseable 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 technical product data on fuses, including specifications, electrical characteristics, installation instructions, furnished specialties and accessories. In addition, include voltages and current ratings, interrupting ratings, current limitation ratings, time-current trip characteristic curves, and mounting requirements. Time-current curves must be full size as provided by the fuse manufacturer and printed on vellum or mylar.

PART 2 - PRODUCTS

FUSES

General: Except as otherwise indicated, provide fuses of types, sizes, ratings, and average time-current and peak let-through current characteristics indicated, which comply with manufacturer's standard design, materials, and constructed in accordance with published product information, and with industry standards and configurations.

Class RK1 Time-Delay Fuses: Provide UL Class RK1 time-delay fuses, 60 Hz, ampere and voltage rated as indicated on the Drawings with 200,000 Ampere RMS symmetrical interrupting current rating.

Class RK5 Time-Delay Fuses: Provide UL Class RK5 time-delay fuses, 60 Hz, ampere and voltage rated as indicated on the Drawings with 200,000 Ampere RMS symmetrical interrupting current rating for protecting motors.

Spare Fuses: Furnish ten (10%) percent spare fuses (or three {3}, whichever is greater) of each size and type installed in equipment, including integrally-fused MCCB's. This includes fuses for equipment furnished by others.

Fuse Cabinet: Furnish and install one (1) 30" x 24" x 12" surface-mounted, NEMA 1 storage cabinet with hinged door, locking handle and cylinder type lock and two (2) shelves. Spare fuses will be stored in this cabinet. Cabinet shall be as manufactured by Bussmann or engineer approved equivalent.

Applicable provisions of this section apply to switches and fused switches that are supplied as a part of panelboards or other equipment.

PART 3 - EXECUTION

EXAMINATION

Examine areas and conditions under which fuses 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 satisfactory conditions have been corrected in a manner acceptable to A-E.

INSTALLATION OF FUSES

Where Fuses Are To Be Installed, Comply With the Following:

Install fuses as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to ensure that protective devices comply with requirements. Comply with NEC, and NEMA standards for installation of fuses.

Coordinate with other work, including electrical wiring, as necessary, to interface installation of fuses with other work.

Install fuses in fused safety switches.

FIELD QUALITY CONTROL

Prior to energization of fuseable devices, test devices for continuity of circuitry and for short-circuits. Replace malfunctioning units with new units, and then demonstrate compliance with requirements.

END OF SECTION 262813

SECTION 265000 - LIGHTING 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

Manufacturer's Qualifications: Firms regularly engaged in the manufacture of interior lighting fixtures of types, sizes, and ratings required, whose products are Listed and Labeled.

Codes and Standards:

Electrical Code Compliance: Comply with applicable State building code requirements, the requirements of the authority having jurisdiction, and the NEC as applicable to installation and construction of lighting fixtures.

NEMA Compliance: Comply with applicable requirements of NEMA Stds Pub/No.'s LE 1 and LE 2 pertaining to lighting equipment. Comply with applicable requirements of NEMA Std. Pub No.'s 1B 4, 1B 5, and FA 1 pertaining to emergency lighting. Comply with NEMA Std. Pub. No.'s SH 5 and TT 1 pertaining to pole/standard construction materials, installation and pole hardware.

Testing Laboratory Compliance: Comply with UL standards, including UL 486A and B, pertaining to interior lighting fixtures. Provide lighting fixtures and components that are Listed and Labeled.

ANSI Compliance: Provide lamp ballast which comply with ANSI C82.

NFPA Compliance: Comply with applicable requirements of NFPA 99, "Health Care Facilities" and NFPA 101, "Life Safety Code."

NC Code Compliance: Comply with applicable requirements of current NC Energy Code.

IEC Compliance: Provide LED drivers and transformers which comply with IEC 61000-3-2 – Harmonic current emissions.

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 product data and installation instructions on each type interior building lighting fixture and component. Include product data on lamps and ballasts used for each fixture type. Submit manufacturer's data from the ballast manufacturer that certifies compatibility for the lamps served. Include warranty data for each fixture type.

Photometric Data: Where indicated below or for substitutions, supply complete photometric data for the fixture, including optical performance, rendered by NVLAP approved laboratory developed according to the methods of the Illuminating Engineering Society of North America. Submit electronically, in IESNA LM-63 standard format.

Shop Drawings: Submit layout drawings of interior lighting fixtures and their spatial relationship to each other. In addition, submit fixture shop drawings in booklet form with separate sheet for each fixture, assembled in "luminaire type" alphabetical or numerical order, with proposed fixture and accessories clearly indicated on each sheet. Submit details indicating compatibility with ceiling system and methods of support for each interior fixture type. Mounting standards or poles for each exterior fixture type shall be clearly indicated, include certified dimensioned drawings for fabricated poles, standards and mast arms.

Maintenance Data: Submit maintenance data and parts list for each interior lighting fixture and accessory; including "trouble- shooting" maintenance guide. Include that data, product data, and shop drawings in a maintenance manual submitted in accordance with requirements of Division 1.

Specification Sheets: If lacking sufficient detail to indicate compliance with contract documents, standard specification sheets will not be accepted. This includes, as applicable to the respective luminaire source, but is not limited to, luminaire type designation, manufacturer's complete catalog number, voltage, LED type, CCT, CRI, specific driver information, system efficacy, lumen maintenance (L70) rating, Total Harmonic Distortion (THD), R9 color value, driver/transformer IEC 61000-3-2 compliance, and any modifications necessary to meet the requirements of the contract documents.

Lumen Maintenance Rating: Lumen maintenance ratings shall be identified for LED luminaires, based on short term test data obtained under LM-80 test methods. Long-term lumen maintenance projections shall be based on IES Test Method TM-21-11, to render L70 rating.

PART 2 - PRODUCTS

INTERIOR LIGHTING FIXTURES

General: Provide lighting fixtures of sizes, types and ratings indicated. Fixtures shall be supplied complete with all suspension accessories, canopies, housings, hickey, sockets, starters, holders, reflectors, ballasts, louvers, frames, poles, hangers, standards, and any and all other items necessary to install fixtures.

Provide fixtures with accessories appropriate for all ceiling types into which the fixtures are placed. See architectural Drawings and Specifications to verify ceiling types, modules, or suspension systems appropriate to installation. Refer to the Fixture Schedule for specific fixture requirements.

Fixtures shall have the manufacturer's name, trademark, model number, serial number, date of manufacture (month-year), and lot number as identification permanently marked inside each unit and the outside of each packaging box. Operating characteristics shall be permanently marked inside each unit, including rated voltage and power in Watts and Volt-Ampere.

Recessed lay-in fixtures shall be fabricated of not less than 22 gauge, prime, cold rolled steel, die formed, and welded into a one-piece housing. Recessed lay-in fixtures shall have die embossed housing with the full length die-formed stiffeners for rigidity. Lamp holder brackets shall enclose all wiring and shall be securely fastened to fixture housing. Lamp holder shall be attached with machine screws. Electronic components shall be mounted directly to the housing with not less than two captive bolts or nuts. Finish shall be electrostatically-applied, baked-on alkyd enamel, with minimum 85 percent reflectance. Finish shall be applied only after complete fixture fabrication. Lay-in fixtures shall be field adaptable for either concealed suspension mounting or flanged installation.

All fixture systems in linear, corner, square, rectangular, or other continuous patterns to be of approximate length and configuration as shown on plans. Electrical contractor to be responsible for field measurements to determine exact lengths so that fixture will fit precisely between walls where required. Fixtures to be pre-wired for feeding location as determined by electrical contractor. Fixture to be supplied with steel splines for sides of housing to allow for positive alignment on continuous linear mounting. Fixture to also be supplied with the correct number and size of corners, extensions, end caps, and other associated appurtenances as required to create the indicated pattern. All extraneous components shall match exactly the finished fixture (including baffles) and be provided by same manufacturer as individual fixtures.

Wiring: Provide electrical wiring within fixture suitable for connecting to branch circuit wiring. Maximum temperature at point of connection to branch circuit wiring shall not exceed 75°C.

LED FIXTURES

LED luminaires shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply) and integral controls as per this specification. All electrical components shall be RoHS compliant.

Luminaire shall be designed to operate at an average operating temperature of 25°C. The overall operating temperature range shall be -20°C to 50°C ambient.

Minimum operational life shall be minimum 50,000 hours at 70% light output (L70) when operated at the average operating temperature.

LED luminaire housing to have no visible welding, screws, springs, hooks, rivets, bare LED's or plastic supports. The luminaire shall be a single, self-contained device, not requiring on-site assembly for installation. The power supply and circuit board for the luminaire shall be integral to the unit.

Individual LED's shall be connected such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire. LED Boards shall be suitable for field maintenance and have with plug-in connectors. LED boards shall be upgradable.

LED Drivers: Provide solid state drivers that are modular and field serviceable, capable of operating lamp types indicated. Provide drivers meeting the following minimum requirements:

UL Listed 8750, Sound Rated A.

Lighting regulation: $\pm 10\%$ over design voltage range.

Voltage range: $\pm 10\%$ nominal.

Power factor: >0.90 ; THD: $<20\%$.

Operating range: -20°C to 50°C ambient.

Built-in transient protection per ANSI/IEEE C64.41 2002, Category A.

Must meet requirements of FCC 47 Part 15 (radiated RF).

Dimming: Driver shall be suitable for full-range dimming, where indicated on the Fixture Schedule. Quality of dimming to be defined by dimming range, freedom from perceived flicker or visible stroboscopic flicker, smooth and continuous change in level (no visible steps in transitions), natural square law response to control input, inaudible in 26 db environment, and stable when input voltage conditions fluctuate over what is typically experienced in a commercial environment. Dimming range shall be 100% to 5% of rated lumen output with a smooth shut off function.

Drivers shall track evenly at all light levels, and shall have an input signal to output light level that allows smooth adjustment over the entire dimming range.

The electronics/power supply enclosure shall be internal to the luminaire and be accessible per UL requirements.

Surge Suppression: The luminaire shall include surge protection within the driver to withstand high repetition noise and other interference.

In Rush Current: Meet or exceed NEMA 410 driver inrush standard of 430 Amps per 10 Amps of load, with a maximum value of $370 \text{ amps}^2 - \text{seconds}$.

RF Interference: The luminaire and associated on-board circuitry must meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 Non-Consumer requirements for EMI/RFI emissions.

Electrical connections between normal power and driver must be modular utilizing a snap fit connector. All electrical components must be easily accessible after installation and be replaceable without removing the fixture from the ceiling.

The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life.

The driver manufacturer's maximum case temperature shall be stated in the product submittal and shall not be exceeded at the maximum operating ambient. Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed.

Warranty: The manufacturer shall provide a single source, 5 year minimum limited warranty against loss of performance and defects in materials and workmanship for all components of the luminaire. Warranty is from the time of acceptance of the Luminaires. All warranty documentation shall be provided to customer prior to the first shipment. Provide manufacturer's warranty covering 5 years minimum on drivers from date of acceptance.

Lamps:

Provide LED lamps of types and wattages as indicated in the Fixture Schedule. Correlated Color temperature (CCT) of 4000K shall be correlated to chromaticity as defined by the absolute (X, Y) coordinates on the 2-D CIE chromaticity chart. Color shift over 6,000 hours shall be <0.007 change in u' v' as demonstrated in IES LM-80 report.

LED lamp R9 value shall be 50 or greater. The color rendition index (CRI) shall be a minimum of 80. LED boards to be tested for color consistency and shall be within a space of 2.5 MacAdam ellipses on the CIE chromaticity chart.

EXTERIOR LIGHTING FIXTURES, POLES AND STANDARDS

General: Provide lighting fixtures, of sizes, types and ratings indicated, complete with, but not limited to, housings, energy efficient ballasts, starters and wiring. Refer to the Fixture Schedule for types and requirements of exterior lighting fixtures.

Fixtures shall have the manufacturer's name, trademark, model number, serial number, date of manufacture (month-year), and lot number as identification permanently marked inside each unit and the outside of each packaging box. Operating characteristics shall be permanently marked inside each unit, including rated voltage and power in Watts and Volt-Ampere.

Wiring: Provide electrical wiring within fixture suitable for connection to branch circuit wiring as follows:

NEC Type SF-1 for 120 Volts, minimum No. 18 AWG.

NEC Type SF-2 for 277 Volts, minimum No. 18 AWG.

Control: Provide individual photocell control of all fixtures unless otherwise indicated on the Drawings.

High-Intensity-Discharge Lamp Ballasts: Provide HID lamp ballasts, capable of operating lamp types with ratings indicated. Ballast shall be of the autotransformer type, high power-factor, with core and coil assembly encapsulated in non-melt resin. Capacitor shall be installed outside ballast encapsulation for easy field replacement. Ballast shall be located at the lamp location, or if remotely located shall be connected to the lamp with conductors not smaller than #12 THWN copper.

Drivers shall be of the multiple tap type and shall, as a minimum, allow operation at either 120, 208, 240, and 277 Volts or 480 Volts, nominal. Drivers shall be Listed and Labeled for use at 0° C.

The maximum lamp cutoff (dropout) voltage for ballasts operating at 277 volts shall not be above 212 volts. The maximum lamp cutoff (dropout) voltage for ballasts operating at 480 volts shall not be above 370 volts.

Lamps: Provide clear/phosphor coated mercury metal halide, mercury vapor, or high pressure sodium lamps in wattages indicated in the Fixture Schedule.

Steel Lighting Standards: Provide steel, raceway-type, lighting poles and standards, of sizes and types indicated, comprised of shaft and bracket.

Metal Lighting Standards: Provide accessories for metal lighting standards, including anchor bolts recommended by lighting standard manufacturer, of sizes and materials needed to meet erection and load application requirements.

Exterior LED luminaires shall be designed to operate at an average operating temperature of 35°C. The operating temperature range shall be -20°C to +50°C. CRI index shall be a minimum for 70. Lamp/driver assembly shall be multi-tap, accepting voltages of 120, 208, 240, and 277 Volts.

LED drivers shall be designed for power factor > 90%, THD, 20%, with serviceable surge protection device meeting minimum Category C Low operation per ANSI/IEEE C64.41.2.

EMERGENCY LIGHTING FIXTURES

General: Provide lighting fixtures, of sizes, types and ratings indicated complete with, but not limited to, housings, batteries, lamps, lamp holders, reflectors, energy-efficient ballasts, starters, and wiring.

Wiring: Provide wiring within fixtures for connection to branch circuit wiring as follows:

NEC Type SF-2 for 120 Volt, minimum No. 18 AWG.

Exit Fixtures - Battery Powered: Provide surface, wall, or ceiling mounted Light Emitting Diode (LED) type fixtures as indicated. Fixtures shall have selectable exit arrow directions. The arrow directions, where indicated on the Drawings, shall be selected to point as shown.

Legend Panels: Provide panels or other legend medium with permanent letters, minimum size to be: 6" high, 3/4" stroke. Letter color and background color shall be the same as the fixture indicated in the Fixture Schedule. Provide special wording on legend panels in lieu of "EXIT" where indicated in the Fixture Schedule.

Emergency Lights - Battery Powered: Provide surface, wall, or ceiling mounted emergency fixtures as indicated. Light units shall operate at 12 VDC. Provide two, incandescent lamps in heads that permit azimuth and elevation adjustments to provide accurate aiming. In selected fixtures as indicated on the Fixture Schedule, the emergency light feature may be combined with the exit sign as a single fixture.

Provide charging system for exit and emergency fixtures that are automatic solid state, full wave rectifying, current limiting type. Systems shall be furnished complete with nickel cadmium battery which shall be automatically connected to the lamps upon loss of AC power. Batteries shall be a high temperature type with an operating range from 0-60 degrees C and contain a re-sealable pressure vent. Normal life expectancy for battery shall be no less than 10 years. The battery shall be sized to supply light for a minimum of 90 minutes unless otherwise specified in the Fixture Schedule. Upon restoration of normal AC supply the unit shall return to the pre-loss condition. Provide a test push button and a fault indicator light that indicates battery or charging system failure; provide any accessory items as described in the Fixture Schedule.

Provide exit and emergency fixtures with pilot light to indicate the unit is connected to A.C. power. The battery shall have high rate charge pilot light, unless self-diagnostic type. Provide a test switch to simulate the operation of the unit upon loss of A.C. power by energizing the lamps from the battery. This simulation must also exercise the transfer relay.

Provide exit and emergency fixtures with manufacturer's three year warranty. The battery must have an additional two more years pro-rated warranty. Warranty shall start from the date of project final acceptance. Warranty shall be included in the contract document.

PART 3 - EXECUTION

EXAMINATION

Examine areas and conditions under which lighting fixtures are to be installed, and substrate for supporting lighting fixtures. 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.

INSTALLATION OF INTERIOR LIGHTING FIXTURES

Install interior lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation," NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.

Where fixtures are supported directly from an outlet box, provide fixtures and/or fixture outlet boxes with hangers to properly support fixture weight. Submit design of hangers, method of fastening, other than indicated or specified herein, for review by A-E.

1 Install flush mounted fixtures properly to eliminate light leakage between fixture frame and finished surfaces.

2
3 Provide plaster frames for recessed fixtures installed in other than suspended grid type acoustical ceiling systems.
4 Brace frames temporarily to prevent distortion during handling.

5
6 Fasten fixtures securely to indicated structural supports; ensure that pendant fixtures are plumb and level. Provide
7 individually mounted pendant fixtures longer than 2 feet with twin stem hangers. Provide stem hanger with ball
8 aligners and provisions for minimum one inch vertical adjustment. Mount continuous rows of fixtures with an
9 additional stem hanger greater than number of fixtures in the row.

10
11 Lighting fixtures, related junction boxes, and conduit are to be supported directly from the building structure. Support
12 fixture independently from each corner using ceiling grid gauge wire; use of the ceiling grid or wires supporting ceiling
13 grid to support fixtures, junction boxes, or conduit is not permitted. Provide a screw at four corners to secure fixture
14 to ceiling grid system.

15
16 Support surface mounted fixtures greater than 2 feet in length at two points in addition to the outlet box fixture stud.

17
18 Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's
19 published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not
20 indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std 486A and B, and
21 the National Electrical Code. Tap connections are permitted within fixtures that are mounted end-to-end and supplied
22 with power from a single end.

23
24 Otherwise, no splices, other than those necessary for the connection of a single fixture, shall be made within a fixture
25 enclosure.

26 27 28 **INSTALLATION OF EXTERIOR LIGHTING FIXTURES, POLES AND STANDARDS**

29
30 Install exterior lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written
31 instructions, applicable requirements of NEC, NECA's "Standard of Installation," NEMA standards, and with
32 recognized industry practices to ensure that lighting fixtures fulfill requirements.

33
34 Coordinate with other electrical work as appropriate to properly interface installation of exterior lighting fixtures with
35 other work.

36
37 Tighten connectors and terminals, including screws and bolts, to comply with tightening torques specified in UL Std.
38 486A and B.

39
40 Fasten fixtures securely to poles or other mounting support as required. Ensure that poles are plumb.

41
42 Install lighting poles and standards as indicated, in accordance with manufacturer's written instructions, in compliance
43 with National Electrical Safety Code and NECA's "Standard of Installation" to ensure that poles and standards comply
44 with requirements.

45
46 To protect finishes, use belt slings or rope (not chain or cable) to raise and set finished poles and standards.
47 Set poles and standards plumb. Support adequately during back-filling, or when anchoring to foundations.

48
49 Provide sufficient space encompassing hand access and cable entrance holes for installation of cables from
50 underground where indicated.

51 52 53 **INSTALLATION OF EMERGENCY LIGHTING FIXTURES**

54
55 Install emergency lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's
56 written instructions, applicable requirements of NEC, NECA's "Standard of Installation," NEMA standards, and with
57 recognized industry practices to ensure that lighting fixtures fulfill requirements.

58
59 Coordinate with other electrical work as appropriate to properly interface installation of emergency lighting fixtures
60 with other work.

1 Wall mounted fixtures shall be installed plumb and vertical. Fixtures shall be located as shown on the Drawings,
2 mounted to fixture boxes or other suitable boxes with matching plaster rings as required by the type of construction.
3 Where used over single doors, the fixture shall be centered in the door opening. Where used over double doors, the
4 fixture shall be centered over either the center of the door or over the exit side of the door as indicated in the
5 Drawings. Where emergency lighting is used at a door location and ceiling height is low, fixtures shall be mounted so
6 that there is no conflict between the door swing and the fixture.

7
8 Ceiling mounted fixtures shall be supported from fixture boxes or other suitable boxes with matching plaster rings as
9 required by the type of construction. Fixture boxes used to support ceiling mounted fixtures shall be supported
10 directly by the building structure using threaded rod and appropriate hardware. Use of grid ceiling tile, grid support
11 wires, or grid members for the support of emergency fixtures shall not be permitted.

12 13 14 **FIELD QUALITY CONTROL**

15
16 Replace defective and burned out lamps for a period of one year following approval of final inspection.

17
18 After approval of final inspection, replace lamps in interior lighting fixtures that are observed to be noticeably dimmed
19 after Contractor's use and testing, as judged by Engineer.

20
21 Upon completion of installation of emergency lighting fixtures, and after building circuitry has been energized with
22 normal power source, apply electrical energy to demonstrate capability and compliance with requirements. Test
23 emergency lighting after units have been permanently installed and charged per manufacturer's instructions, but no
24 less than 24 hours. Batteries shall be tested for 90 minutes and meet the minimum illumination requirements of
25 NFPA-101. Record illumination level at floor level beneath each unit before and after test and submit to engineer for
26 review. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise,
27 remove and replace with new units, and proceed with retesting.

28 29 30 **ADJUSTING AND CLEANING**

31
32 Clean lighting fixtures of dirt and construction debris upon completion of installation. Clean fingerprints and smudges
33 from lenses.

34
35 Protect installed fixtures from damage during remainder of construction period.

36 37 38 **GROUNDING**

39
40 Provide equipment grounding connections for all interior lighting fixtures. Each interior lighting fixture shall be
41 grounded by means of a separate insulated grounded conductor routed with the ungrounded conductor(s). The
42 grounding conductor to each fixture shall terminate on a dedicated green screw within the fixture itself. Tighten
43 connections to comply with tightening torques specified in UL Std. 486A to assure permanent and effective grounds.

44
45
46 **END OF SECTION 265000**

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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	15 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.

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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.

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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.

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SECTION 270528 – TELEPHONE/DATA RACEWAY 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

Codes and Standards:

NEC Compliance: Comply with NEC as applicable to communication system materials and installations.

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 terminal cabinet.

PART 2 - PRODUCTS

TERMINAL CABINETS

General: Except as otherwise indicated, provide terminal cabinets and ancillary components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials. Cabinets shall be designed and constructed in accordance with published product information. Cabinets shall be equipped with 3/4" thick exterior grade plywood backboard, painted white as required for complete installation. Where sizes are not indicated, comply with NEC and UL standards for those applications indicated.

Terminal Cabinet Enclosures: Provide galvanized sheet steel cabinet type enclosures, in sizes and NEMA types as indicated, code gauge, minimum 16 gauge thickness. Construct with multiple knockouts and wiring gutters. Provide fronts with adjustable trim clamps and doors with flush locks and keys, with concealed piano door hinges and left hand door swing unless otherwise indicated. Cabinets shall be equipped with interior circuit directory frame, and card with clear plastic covering. Provide baked gray enamel finish over a rust inhibitor coating. Design enclosures for recessed mounting. Provide enclosures that are fabricated by same manufacturer as panelboards.

Backboards: Provide backboards in the locations indicated on the drawings. Backboards shall be the size indicated and composed of 3/4" thick fire resistant plywood, painted white with paint as required for complete installation. Paint shall not cover labels or markings indicating fire resistance rating.

PART 3 - EXECUTION

INSTALLATION OF TELEPHONE /DATA RACEWAYS

Install telephone/data raceway system as indicated. Unless otherwise specified on the drawings all outlet locations receive a 1" EMT conduit run from the outlet backbox to the equipment cabinet or backboard serving that location. Other requirements are detailed on the Drawings.

Provide an insulated throat EMT connector on the end of the conduit to protect the wire(s) from abrasion where cables enter or exit the open end of a conduit. Where conduit terminates at a backboard, secure conduit at the top of the backboard by means of appropriate conduit clamps.

- 1 Coordinate with other electrical work, including raceways, electrical boxes and fittings, as necessary to interface
- 2 installation of telephone/data raceways with other work.
- 3
- 4 Install pull wire in each telephone/data raceway. Label each conduit as specified in Section 260533, *ELECTRICAL*
- 5 *IDENTIFICATION*, to indicate room number of termination of the conduit run.
- 6
- 7
- 8 **END OF SECTION 270528**

SECTION 272000 – TELECOMMUNICATIONS 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. Refer to the drawings for equipment schedules related to each system.

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 6A 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.

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. Include TMGB and TGB documentation within submittal.

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. Include grounding connections in this diagram.

Contractor shall provide three (3) sets of drawings marked with jack numbers. Drawings shall also be provided on a CD in AutoCAD and PDF format. One set of cable drawings shall be installed in each telecommunications room.

Plan view drawings: Submit a detailed plan view drawing down to the outlet level (including floor, wall, and ceiling outlets) showing the location of cable pathway segments that utilize hangars and supports. Drawings shall indicate all horizontal and vertical conduit routing, cable trays, and pull box locations. Conduit runs to individual outlets are not required to be shown. Utilize D for data, T for telephone, and V for video outlets on the floor plan. Include plan and elevation views showing equipment room size and layout including rack locations, equipment rack configuration, door size, environmental supply/return, TMGB/TGB location, power outlet locations, cable pathways, sleeve locations, lighting, cable ladder routing, HVAC supply/return locations, and installation requirements.

Faceplate details drawing shall indicate faceplate and faceplate termination hardware layout.

Submit Elevation / coordination drawings showing relationship between cable trays and all other trades (HVAC, fire protection, lighting, etc.)

Submit detailed sketch of the faceplate identification and labeling method.

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.

Test Plan: Submit a detailed plan for testing each communications and infrastructure component in PDF format. The test plan submittal shall include a sample of testing documentation and proposed test equipment. Testing shall consist of an end-to-end system test, encompassing the cable, patch panel termination, and faceplate termination, as appropriate.

The contractor shall test UTP cable in accordance with TIA-568-C series standards, including TIA-568-C.0, TIA-568-C.1, TIA-568-C.2, TIA-568-C.3, TIA-568-C.4, and TSB-140. Each UTP cable shall be tested and the results documented and delivered to the owner's representative for review/acceptance.

Copper cabling shall be fully tested for Cat6 compliance in the TIA specifications, including the following parameters: DC resistance, open pairs, shorted pairs, split pairs, reversed conductors, NEXT (test from both ends), ELFEXT, return loss, and delay skew.

Attend a pre-install meeting with WTCC ITS prior to commencing installation activities. The meeting shall be held at a location determined by WTCC.

PART 2 - PRODUCTS

OUTLET JACKS

Outlet jacks shall be modular with snap-in modules capable of numerous jack module combinations including RJ45, Fiber LC, 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.

Jacks shall be Hubbell Part No. HXJ6BK and shall be wired as per TIA-568-B.

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.

Preferred Brand: Corning.

- A. Copper horizontal (outlet) and riser (backbone) cable station shall be UL listed, TIA / EIA Unshielded Twisted Pair – 100 ohm Category 6A 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 data and green cable for security, one cable per jack.

Category 6A

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	2.1	75.3	72.3	72.3	70.2	20.0	67.8	64.8
4	3.8	66.3	62.5	63.3	59.5	23.0	55.8	52.8
10	5.9	60.3	54.4	57.3	51.4	25.0	47.8	44.8
16	7.5	57.2	49.8	54.2	46.8	25.7	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	10.8	52.9	42.4	49.9	39.4	23.6	37.9	34.9
62.5	15.0	48.4	33.4	45.4	30.4	21.5	31.9	28.9
100	19.1	45.3	26.2	42.3	23.2	20.1	27.8	24.8
250	31.1	39.3	8.3	36.3	5.3	17.3	24.8	21.8
400	40.1	36.3	-3.8	33.3	-6.8	15.9	21.8	18.8
500	45.3	34.8	-10.4	31.8	-13.4	15.2	19.8	16.8

Notes:

- Values are specified or calculated, based upon TIA 568-C.X.
- 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

- 1 Fiber connectors: LC .75 dB maximum insertion loss
2
3 Cable bend radius: 10 times diameter
4
5 Provide number of fiber strands and cable configurations as outlined in riser diagram.
6
7 C. Single mode fiber optic cables shall be 8.3/125 micron Class IVa Dispersion-Unshifted Single-mode Optical
8 Fiber. Cable shall be OFNR (riser rated) for use on risers where enclosed in metallic raceways and OFNP
9 (plenum rated) otherwise. Service cables shall be Outside Plant or Indoor / Outdoor (I/O) NEC Rating. All
10 fiber cable shall be FDDI Compliant.
11
12 Coating Diameter: 250 Microns Core Eccentricity: 7.5% maximum
13 (1.5% typical)
14
15 Attenuation: 0.5 dB/km @ 1310 NM .5 dB/km @ 1550 NM
16 Zero dispersion wavelength 1300 -1320 NM
17
18 Fiber connectors: LC .75 dB maximum insertion loss
19
20 Cable bend radius: 10 times diameter
21
22 Provide number of fiber strands and cable configurations as outlined in riser diagram.
23
24

25 **TERMINATION**

26
27 Copper Patch Panels: Provide 24/48 port, rack mountable, modular to 110, Category 6A compliant patch panels.
28 Panels to use TIA / EIA 568C wiring scheme.
29

30 Owner preferred patch panel: Hubbell P6E48U or approved equal.
31

32 Fiber Termination Panels: Provide a rack mountable, modular cabinet capable of terminating up to 24 type LC
33 multimode fiber cables.
34

35 At termination points for copper distribution cable that exits the building, provide surge suppression protectors near to
36 the exit/entrance point to the building. All protectors shall be grounded using AWG 12 (minimum) copper wire for
37 single line or double line, AWG 10 for three through six lines, and AWG 6 for seven or more lines. This conductor
38 shall be grounded in accordance with NEC 800.100. The primary protector shall be 189B1 with AT&T 3C1SC
39 equivalent protector units (solid state type).
40

41 **ENCLOSURES**

42
43 19" Racks – Provide 7' tall, 19" supporting rack with black anodized aluminum cross members. Rack to be securely
44 bolted to floor. Owner's preferred item: Chatsworth two post 19 inch Part No. 55053-703 or approved equal.
45
46

47 Owner preferred front horizontal wire management module Panduit Dual Sided Horizontal Cable Manager - 2 RU
48 (SKU: WMP1E) placed above and below each Cat 6a data patch panel.
49

50 Owner preferred enclosed server rack is APC E242296.
51

52 Owner preferred vertical wire management Panduit WMPVHC45E. Vertical wire manager shall be placed on both
53 sides of the equipment rack and/or between each equipment rack.
54

55 Telephone Backboards – Provide telephone backboards sized and located as indicated on the drawings.
56 Backboards to be composed of 3/4" thick fire retardant exterior grade plywood. Backboard to be painted white as
57 noted on plans.
58
59
60
61
62

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. The use of J-hooks or cable hangers are not permitted.

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.

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.

CABLE PULLING

Install cables splice-free.

Contractor shall provide all required installation tools to facilitate cable pulling without damage to cable jacket.

Pull all cable by hand unless installation conditions require mechanical assistance. Where mechanical assistance is used, care shall be taken to insure that maximum tensile load for cable as defined by these specifications is not exceeded. This may be in the form of continuous monitoring of pulling tension, use of "break-away" or other approved method.

Pull cables in accordance with cable manufacturer's recommendations and NFPA-70. All cabling shall be installed in compliance with TIA- 568-C series standards. Manufacturer's recommendations shall be part of cable submittal. Recommended pulling tensions and pulling bending radius shall not be exceeded. Any cables bent or kinked to radius less than recommended dimension will not be allowed.

During pulling operation adequate number of workers shall be present to allow cable observation at all points of raceway entry and exit, as well as to feed cable and operate pulling machinery.

Pulling lubricant may be used to ease pulling tensions. Lubricant shall be of type that is non-injurious to cable jacket and other materials used. Lubricant shall not harden or become adhesive with age.

Pull string (nylon; 1/8" minimum) shall be installed with cable installed in all conduits and inner ducts. Pull strings shall be tagged in MDF and IDF and at each corresponding outlet to identify where the string terminates on each floor.

Cable pulls shall be done left to right between the two racks and punched down top to bottom.

Where equipment is located in a plenum, all conductors, cables, cable ties, fittings, and all other equipment shall be rated for use in a plenum space.

UTP TESTING

Category 6A: 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. Testing shall consist of an end-to-end system test, encompassing the cable, patch panel termination, and faceplate termination.

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).
16. DC resistance
17. Open pairs, shorted pairs, and split pairs
18. Reversed conductors

Contractor shall notify the Owner a minimum of twenty one (21) work days in advance of any testing to be performed with details about the specific location of the test and functions to be tested. The Owner may elect to be present for any or all tests performed.

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 are required for all fiber optic cables.

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. See plans for a sample labeling diagram.

Building IDs and room numbers are assigned by WTCC Facilities. The Contractor shall check with the college project manager to ensure the proper building ID and room numbers are used when labeling communications systems components.

Racks in TRs shall be labeled sequentially, 1 through 4. The label shall be machine generated, at least 1.5" high and have black letters on a white background. The label shall be plastic or vinyl and adhered to the center of the rack if possible.

Patch panels are assigned an ID based on the room number (205), rack (1) and location in rack (A thru J). All patch panels shall be labeled to indicate the patch panel name. Labels shall be machine-generated, high contrast and between 1/2" and 1" high.

All cable shall be labeled both at the outlet and the patch panel with an alpha/numeric identification code using the following format: The patch panel will point to the room (237) and the outlet location the cable terminates in (10) is: 237.10. The outlet 10 in room 237 will point to the IDF room number (239) and rack ID (1) and patch panel location (D) and port (23) i.e.: 239.1.D.23 .

For Fire Alarm lines "Room FA-1 /Room FA-2", for Elevator phones "Room Elev 1 / Room Elev 2", and for Emergency phones "Room Emer 1 /Room Emer 2".

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 311000 - SITE CLEARING

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. Protecting existing trees, shrubs, groundcovers, plants, and grass to remain.
2. Removing existing trees, shrubs, groundcovers, plants and grass.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and removing site utilities.
7. Temporary erosion and sedimentation control measures.

- B. Related Sections include the following:

1. Division 01 Section "Temporary Facilities and Controls" for temporary utilities, temporary construction and support facilities, temporary security and protection facilities, and temporary erosion and sedimentation control procedures.
2. Division 01 Section "Temporary Tree and Plant Protection" for protecting trees remaining on-site that are affected by site operations.
3. Division 01 Section "Execution" for verifying utility locations and for recording field measurements.
4. Division 02 Section "Structure Demolition" for demolition of buildings, structures, and site improvements.
5. Division 31 Section "Earth Moving" for soil materials, excavating, backfilling, and site grading.
6. Division 23 Section "Turf and Grasses and Plants" for finish grading including preparing and placing planting soil mixes and testing of topsoil material.

1.3 DEFINITIONS

- A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; 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 non-soil materials.

- B. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

1.4 MATERIAL OWNERSHIP

- A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 SUBMITTALS

- A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.
- B. Record drawings, according to Division 01 Section "Project Record Documents," identifying and accurately locating capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 QUALITY ASSURANCE

- A. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.7 PROJECT CONDITIONS

- A. 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 authorities having jurisdiction.
- B. Improvements on Adjoining Property: Authority for performing site clearing 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 Architect.
- C. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
- D. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- E. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly flag trees and vegetation to remain or to be relocated.
- C. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 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 a sediment and erosion control plan, specific to the site that complies with EPA 832/R-92-005 or requirements of authorities having jurisdiction, whichever is more stringent.
- B. Inspect, repair, and maintain 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.

3.3 TREE PROTECTION

- A. Erect and maintain temporary fencing around tree protection zones before starting site clearing. Remove fence when construction is complete.
 - 1. Do not store construction materials, debris, or excavated material within fenced area.
 - 2. Do not permit vehicles, equipment, or foot traffic within fenced area.
 - 3. Maintain fenced area free of weeds and trash.
- B. Do not excavate within tree protection zones, unless otherwise indicated.
- C. Where excavation for new construction is required within tree protection zones, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.
 - 1. Cover exposed roots with burlap and water regularly.
 - 2. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.

3. Coat cut faces of roots more than 1-1/2 inches in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
 4. Backfill with soil as soon as possible.
- D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Architect.
1. Employ an arborist, licensed in jurisdiction where Project is located, to submit details of proposed repairs and to repair damage to trees and shrubs.
 2. Replace trees that cannot be repaired and restored to full-growth status, as determined by Architect.

3.4 UTILITIES

- A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.
1. Arrange with utility companies to shut off indicated utilities.
 2. Owner will arrange to shut off indicated utilities when requested by Contractor.
- B. 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 Architect not less than two days in advance of proposed utility interruptions.
 2. Do not proceed with utility interruptions without Architect's written permission.
- C. Excavate for and remove underground utilities indicated to be removed.

3.5 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, grass, 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. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
 3. Grind stumps and remove roots, obstructions, and debris extending to a depth of 18 inches below exposed subgrade.
 4. Use only hand methods for grubbing within tree protection zone.
 5. Chip removed tree branches and dispose of off-site.
- B. 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.

3.6 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
 - 1. Remove subsoil and non-soil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 1. Limit height of topsoil stockpiles to 72 inches.
 - 2. Do not stockpile topsoil within tree protection zones.
 - 3. Dispose of excess topsoil as specified for waste material disposal.
 - 4. Stockpile surplus topsoil to allow for re-spreading deeper topsoil.

3.7 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and as 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 length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.
 - 2. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion.

3.8 DISPOSAL

- A. Disposal: 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.
 - 1. Separate recyclable materials produced during site clearing from other non-recyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

END OF SECTION 311000

SECTION 312000 - EARTH MOVING

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. Preparing subgrades for slabs-on-grade, walks, pavements, lawns and grasses and exterior plants.
 - 2. Excavating and backfilling for buildings and structures.
 - 3. Drainage course for slabs-on-grade.
 - 4. Sub-base course for concrete walks and pavements.
 - 5. Sub-base and base course for asphalt paving.
 - 6. Subsurface drainage backfill for walls and trenches.
 - 7. Excavating and backfilling for utility trenches.
 - 8. Excavating and backfilling trenches for buried mechanical and electrical utilities and pits for buried utility structures.

1.3 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: Course placed between the sub-base course and hot-mix asphalt paving.
- C. Bedding Course: Course 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.
- E. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
- F. 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 Architect. Authorized additional

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- excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
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 Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.
- G. Fill: Soil materials used to raise existing grades.
- H. 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 (equivalent to a CAT 330), without systematic drilling, ram hammering, ripping, or blasting, when permitted:
1. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch-wide, maximum, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,090 lbf and stick-crowd force of not less than 18,650 lbf; measured according to SAE J-1179.
 2. Bulk Excavation: Late-model, track-mounted loader; rated at not less than 210-hp flywheel power and developing a minimum of 48,510-lbf breakout force with a general-purpose bare bucket; measured according to SAE J-732.
- I. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. or more in volume that exceed a standard penetration resistance of 100 blows/2 inches when tested by an independent geotechnical testing agency, according to ASTM D 1586.
- J. 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.
- K. Sub-base Course: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.
- L. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below sub-base, drainage fill, or topsoil materials.
- M. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.
- 1.4 SUBMITTALS
- A. Product Data: For the following:
1. Each type of plastic warning tape.
 2. Geotextile.
 3. Controlled low-strength material, including design mixture.

- B. 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 earthwork operations. Submit before earthwork begins.

1.5 QUALITY ASSURANCE

- A. Geotechnical Testing Agency Qualifications: An independent testing agency qualified according to ASTM E 329 to conduct soil materials and rock-definition testing, as documented according to ASTM D 3740 and ASTM E 548.
- B. Pre-excavation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.6 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.
 - 1. Notify Architect not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Architect's written permission.
 - 3. Contact utility-locator service for area where Project is located before excavating.
- B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: ASTM D 2487 Soil Classification Groups ML, CL, SM, and SC, 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. At depths greater than 3 feet below finished grades, the following soil types will typically be suitable for use as structural fill: CH and MH.
- C. Unsatisfactory Soils: Soil Classification Groups SW, SP, SP-SM, SP-SC, OL, OH, and Pt according to ASTM D 2487, or a combination of these groups.
 - 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

- D. Sub-base 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.
- E. 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.
- F. 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.
- G. 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.
- H. 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.
- I. 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.
- J. Sand: ASTM C 33; fine aggregate, natural, or manufactured sand.
- K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 GEOTEXTILES

- A. Fabric of polypropylene or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. when tested according to ASTM D 4491.
 - 1. Structure Type:
 - a. Subsurface Drainage Geotextile: Nonwoven geotextile comprised of UV stabilized polypropylene staple fibers with the minimum following characteristics:
 - 1) Grab Tensile Strength, ASTM D4632, 120 lbs. strength at ultimate.
 - 2) Mullen Burst Strength, ASTM D3786, 225 psi.
 - 3) Trapezoidal Tear Strength, ASTM D4355, 50 lbs.
 - 4) Puncture Strength, ASTM D4833, 65 lbs.
 - 5) UV Resistance after 500 hours, ASTM D4355, 70% strength.
 - 6) Apparent Opening Size (AOS), ASTM D4751, US Sieve 70.
 - 7) Permittivity, ASTM D4491, 1.7 sec⁻¹.
 - b. Separation Geotextile: Woven geotextile comprised of UV stabilized polypropylene slit film with the following characteristics:
 - 1) Grab Tensile Strength, ASTM D4632, 200 lbs. strength at ultimate.

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- 2) Mullen Burst Strength, ASTM D3786, 400 psi.
 - 3) Trapezoidal Tear Strength, ASTM D4355, 75 lbs.
 - 4) Puncture Strength, ASTM D4833, 90 lbs.
 - 5) UV Resistance after 500 hours, ASTM D4355, 70% strength.
 - 6) Apparent Opening Size (AOS), ASTM D4751, US Sieve 50.
 - 7) Permittivity, ASTM D4491, 0.05 sec⁻¹.

2.3 CONTROLLED LOW-STRENGTH MATERIAL

- A. Controlled Low-Strength Material: Low-density, self-compacting, flowable concrete material.
- B. Produce low-density, controlled low-strength material with the following physical properties:
 1. Compressive Strength: 140 psi, when tested according to ASTM C 495.

2.4 ACCESSORIES

- A. 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.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 31 Section "Site Clearing."
- C. Protect and maintain erosion and sedimentation controls, which are specified in Division 31 Section "Site Clearing," during earthwork operations.
- D. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

3.2 DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- B. 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.

3.3 EXPLOSIVES

- A. Explosives: Do not use explosives.

3.4 EXCAVATION, GENERAL

- A. 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 Architect. 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.

3.5 EXCAVATION FOR STRUCTURES

- A. 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. Pile Foundations: Stop excavations 6 to 12 inches above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile 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. Do not disturb bottom of excavations intended as bearing surfaces.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.7 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. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.
 1. Clearance: 12 inches each side of pipe or conduit] [As indicated].
- C. 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 and flat-bottomed, multiple-duct conduit units, 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 circumference. Fill depressions with tamped sand backfill.
 3. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
- D. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe elevation to allow for bedding course. Hand excavate for bell of pipe.
 1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.8 SUBGRADE INSPECTION

- A. Notify Architect when excavations have reached required subgrade.
- B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Proof-roll subgrade below slabs and pavements with heavy pneumatic-tired equipment 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. Limit vehicle speed to 3 mph.
 - 2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
 - 3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
- E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.9 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 2500 psi, may be used when approved by Architect.
 - 1. Fill unauthorized excavations under other construction or utility pipe as directed by Architect.

3.10 STORAGE OF SOIL MATERIALS

- A. 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. Do not store within drip line of remaining trees.

3.11 BACKFILL

- A. 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.

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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.

3.12 UTILITY TRENCH BACKFILL

- A. Place backfill on subgrades free of mud, frost, snow, or ice.
- B. 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.
- C. 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."
- D. 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 sub-base.
- E. Place and compact initial backfill of sub-base material or satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the utility pipe or conduit.
 1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
- F. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches over the utility pipe or conduit.
- G. Backfill voids with satisfactory soil while installing and removing shoring and bracing.
- H. Place and compact final backfill of satisfactory soil to final subgrade elevation.
- I. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.
- J. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.13 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. 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.
5. Under footings and foundations, use engineered fill.

- C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.14 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 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. Remove and replace or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.15 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.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:
1. Under structures, slabs, steps, and pavements, scarify and re-compact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
 2. Under walkways, scarify and re-compact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 95 percent.
 3. Under lawn or unpaved areas, scarify and re-compact 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 95 percent.

3.16 GRADING

- A. 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.

- B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
 - 1. Lawn or Unpaved Areas: Plus or minus 1 inch.
 - 2. Walks: Plus or minus 1 inch.
 - 3. Pavements: Plus or minus 1/2 inch.
- C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.17 SUBSURFACE DRAINAGE

- A. Subdrainage Pipe: Specified in Division 33 Section "Subdrainage."
- B. 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 85 percent of maximum dry unit weight according to ASTM D 698 or with a minimum of two passes of a plate-type vibratory compactor.
- C. 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 1 layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
 - 1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698 or with a minimum of two passes of a plate-type vibratory compactor.
 - 2. Place and compact impervious fill over drainage backfill in 6-inch-thick compacted layers to final subgrade.

3.18 SUB-BASE AND BASE COURSES

- A. Place sub-base and base course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place sub-base 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 sub-base course under hot-mix asphalt pavement.
 - 3. Shape sub-base and base course to required crown elevations and cross-slope grades.
 - 4. Place sub-base and base course 6 inches or less in compacted thickness in a single layer.
 - 5. Place sub-base 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.

6. Compact sub-base 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.

- C. Pavement Shoulders: Place shoulders along edges of sub-base and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each sub-base and base layer to not less than 98 percent of maximum dry unit weight according to ASTM D 698.

3.19 DRAINAGE COURSE

- 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.
 4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.20 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.
- B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
- C. 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 Architect.
- D. 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 and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least 1 test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than 3 tests.
 2. Foundation Wall Backfill: At each compacted backfill layer, at least 1 test for each 100 feet or less of wall length, but no fewer than 2 tests.

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3. Trench Backfill: At each compacted initial and final backfill layer, at least 1 test for each 150 feet or less of trench length, but no fewer than 2 tests.

- E. 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 to depth required; re-compact and retest until specified compaction is obtained.

3.21 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. 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 Architect; reshape and re-compact.
- C. 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.

3.22 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION 312000

SECTION 321216 - ASPHALT PAVING

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 milling of existing hot-mix asphalt pavement.
 - 2. Hot-mix asphalt patching.
 - 3. Hot-mix asphalt paving.
 - 4. Hot-mix asphalt paving overlay.
 - 5. Asphalt surface treatments.
 - 6. Pavement-marking paint.

1.3 DEFINITION

- A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
 - 1. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
 - 2. Job-Mix Designs: For each job mix proposed for the Work.
- B. Material Certificates: For each paving material, from manufacturer.
- C. Material Test Reports: For each paving material.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by NCDOT.
- B. Installer Qualifications: Imprinted-asphalt manufacturer's authorized installer who is trained and approved for installation of imprinted asphalt required for this Project.

- C. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.
- D. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of NCDOT and the City of Raleigh for asphalt paving work.
 - 1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.
- E. Pre-installation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:
 - a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
 - b. Review condition of subgrade and preparatory work.
 - c. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.
 - d. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.
- B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
 - 1. Prime Coat: Minimum surface temperature of 60 deg F.
 - 2. Tack Coat: Minimum surface temperature of 60 deg F.
 - 3. Slurry Coat: Comply with weather limitations in ASTM D 3910.
 - 4. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
 - 5. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.
- B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials or 55 deg F for water-based materials], and not exceeding 95 deg F.

- C. Imprinted Asphalt Paving: Proceed with coating imprinted pavement only when air temperature is at least 50 deg F and rising and will not drop below 50 deg F within 8 hours of coating application. Proceed only if no precipitation is expected within two hours after applying the final layer of coating.

PART 2 - PRODUCTS

2.1 AGGREGATES

- A. General: Use materials and gradations that have performed satisfactorily in previous installations.
- B. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.
- C. Fine Aggregate: ASTM D 1073, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.
 - 1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.
- D. Mineral Filler: ASTM D 242, rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

- A. Asphalt Binder: AASHTO M 320 or AASHTO MP 1a, PG 64-22.
- B. Prime Coat: ASTM D 2027, medium-curing cutback asphalt, MC-30 or MC-70.
- C. Prime Coat: Asphalt emulsion prime coat complying with NCDOT requirements.
- D. Tack Coat: ASTM D 977 emulsified asphalt, or ASTM D 2397 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.
- E. Fog Seal: ASTM D 977 emulsified asphalt, or ASTM D 2397 cationic emulsified asphalt, slow setting, factory diluted in water, of suitable grade and consistency for application.
- F. Water: Potable.
- G. Undersealing Asphalt: ASTM D 3141, pumping consistency.

2.3 AUXILIARY MATERIALS

- A. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.
- B. Sand: ASTM D 1073, Grade Nos. 2 or 3.

- C. Paving Geotextile: AASHTO M 288, nonwoven polypropylene; resistant to chemical attack, rot, and mildew; and specifically designed for paving applications.
- D. Joint Sealant: ASTM D 6690, hot-applied, single-component, polymer-modified bituminous sealant.
- E. Wheel Stops: Precast, air-entrained concrete, 2500-psi minimum compressive strength, 4-1/2 inches high by 9 inches wide by 72 inches long. Provide chamfered corners, drainage slots on underside, and holes for anchoring to substrate.
 - 1. Dowels: Galvanized steel, 3/4-inch diameter, 10-inch minimum length.
- F. Wheel Stops: Solid, integrally colored, 96 percent recycled HDPE or commingled postconsumer and postindustrial recycled plastic; UV stabilized; 4 inches high by 6 inches wide by 72 inches. Provide chamfered corners, drainage slots on underside, and holes for anchoring to substrate.
 - 1. Dowels: Galvanized steel, 3/4-inch diameter, 10-inch minimum length.

2.4 MIXES

- A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by NCDOT and designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that subgrade is dry and in suitable condition to begin paving.
- B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment 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. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
 - 3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- C. Proceed with paving only after unsatisfactory conditions have been corrected.
- D. Verify that utilities, traffic loop detectors, and other items requiring a cut and installation beneath the asphalt surface have been completed and that asphalt surface has been repaired flush with adjacent asphalt prior to beginning installation of imprinted asphalt.

3.2 PATCHING

- A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Re-compact existing unbound-aggregate base course to form new subgrade.
- B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.
 - 1. Pump hot undersealing asphalt under rocking slab until slab is stabilized or, if necessary, crack slab into pieces and roll to reseat pieces firmly.
 - 2. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Re-compact existing unbound-aggregate base course to form new subgrade.
- C. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd.
 - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
- D. Patching: Fill excavated pavements with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.
- E. Patching: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3.3 SURFACE PREPARATION

- A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
- B. Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.15 to 0.50 gal./sq. yd. Apply enough material to penetrate and seal but not flood surface. Allow prime coat to cure.
 - 1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
 - 2. Protect primed substrate from damage until ready to receive paving.
- C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.4 HOT-MIX ASPHALT PLACING

- A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
 1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
 2. Place hot-mix asphalt surface course in the number of lifts and thicknesses indicated in the design drawings.
 3. Spread mix at minimum temperature of 250 deg F.
 4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
 5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
 1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.
- C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.5 JOINTS

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
 1. Clean contact surfaces and apply tack coat to joints.
 2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
 3. Offset transverse joints, in successive courses, a minimum of 24 inches.
 4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
 5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
 6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.6 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
 - 1. Complete compaction before mix temperature cools to 185 deg F.
- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
 - 1. Average Density: 96 percent of reference laboratory density according to ASTM D 6927, but not less than 94 percent nor greater than 100 percent.
 - 2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
- F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
- G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.7 INSTALLATION TOLERANCES

- A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
 - 1. Base Course: Plus or minus 1/2 inch.
 - 2. Surface Course: Plus 1/4 inch, no minus.
- B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
 - 1. Base Course: 1/4 inch.

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2. Surface Course: 1/8 inch.
 3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.
- C. Traffic-Calming Devices: Compact and form asphalt to produce the contour indicated and within a tolerance of plus or minus 1/8 inch of height indicated above pavement surface.

3.8 WHEEL STOPS

- A. Install wheel stops in bed of adhesive as recommended by manufacturer.
- B. Securely attach wheel stops to pavement with not less than two galvanized-steel dowels embedded at one-quarter to one-third points. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.

3.9 FIELD QUALITY CONTROL

- A. Testing Agency: The Owner will engage a qualified testing agency to perform tests and inspections.
- B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.
- C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
- D. In-Place Density: Testing agency will take samples of un-compacted paving mixtures and compacted pavement according to ASTM D 979.
 1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
 2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
 - a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than 3 cores taken.
 - b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.
- E. Replace and compact hot-mix asphalt where core tests were taken. Fill core tests with hot-mix asphalt and compact.
- F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.10 DISPOSAL

- A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.
 - 1. Do not allow milled materials to accumulate on-site.

END OF SECTION 321216

SECTION 321313 - CONCRETE PAVING

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 exterior cement concrete pavement for the following:
 - 1. Driveways and roadways.
 - 2. Parking lots.
 - 3. Curbs and gutters.
 - 4. Walkways.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 SUBMITTALS

- A. Product Data: For each type of manufactured material and product indicated.
- B. Design Mixtures: For each concrete pavement mixture. Include alternate mixture designs when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
- C. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:
 - 1. Cementitious materials.
 - 2. Steel reinforcement and reinforcement accessories.
 - 3. Fiber reinforcement.
 - 4. Admixtures.
 - 5. Curing compounds.
 - 6. Applied finish materials.
 - 7. Bonding agent or epoxy adhesive.
 - 8. Joint fillers.
- D. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who 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."
- B. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
- C. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.
- D. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
- E. Mockups: Cast mockups of full-size sections of concrete pavement to demonstrate typical joints, surface finish, texture, color, and standard of workmanship.
 - 1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
 - 2. Notify Architect seven days in advance of dates and times when mockups will be constructed.
 - 3. Obtain Architect's approval of mockups before starting construction.
 - 4. Maintain approved mockups during construction in an undisturbed condition as a standard for judging the completed pavement.
 - 5. Demolish and remove approved mockups from the site when directed by Architect.
 - 6. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- F. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
 - 1. Before submitting design mixtures, review concrete pavement mixture design and examine procedures for ensuring quality of concrete materials and concrete pavement construction practices. Require representatives, including the following, of each entity directly concerned with concrete pavement, to attend conference:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete producer.
 - d. Concrete pavement subcontractor.

1.6 PROJECT CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
 - 2. Products: Subject to compliance with requirements, provide one of the products specified.
 - 3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.
 - 1. Use flexible or curved forms for curves with a radius 100 feet or less.
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

- A. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.
- B. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.
- C. Epoxy-Coated Welded Wire Fabric: ASTM A 884/A 884M, Class A, plain steel.
- D. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.
- E. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A 615/A 615M, Grade 60 deformed bars.

- F. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 deformed bars.
- G. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60, deformed bars; assembled with clips.
- H. Deformed-Steel Wire: ASTM A 496.
- I. Joint Dowel Bars: Plain steel bars, ASTM A 615/A 615M, Grade 60. Cut bars true to length with ends square and free of burrs.
- J. Epoxy-Coated Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60, plain steel bars.
- K. Tie Bars: ASTM A 615/A 615M, Grade 60, deformed.
- L. Hook Bolts: ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against pavement form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.
- M. 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, 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.
- N. Epoxy Repair Coating: Liquid two-part epoxy repair coating, compatible with epoxy coating on reinforcement.
- O. Zinc Repair Material: ASTM A 780.

2.4 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout the Project:
 - 1. Portland Cement: ASTM C 150, Type I/II. Supplement with the following:
 - a. Fly Ash: ASTM C 618, Class C or F.
- B. Normal-Weight Aggregates: ASTM C 33, Class 3M coarse aggregate, uniformly graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar pavement applications and service conditions using similar aggregates and cementitious materials.
- C. Water: ASTM C 94/C 94M.

- D. Air-Entraining Admixture: ASTM C 260.
- E. Chemical Admixtures: Provide 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 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.

2.5 FIBER REINFORCEMENT

- A. Synthetic Fiber: Monofilament or fibrillated polypropylene fibers engineered and designed for use in concrete pavement, complying with ASTM C 1116, Type III, 1/2 to 1-1/2 inches long.

2.6 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.

2.7 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.
- B. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, non-glazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery with emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.
- C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- D. 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 requirements, and as follows:
 - 1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

- E. Chemical Surface Retarder: Water-soluble, liquid-set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch.

2.8 PAVEMENT MARKINGS

- A. Pavement-Marking Paint: According to NCDOT standard specifications and details.

2.9 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301, with the following properties:
 - 1. Compressive Strength (28 Days): As specified on the Drawings.
 - 2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45.
 - 3. Slump Limit: 4 inches.
 - 4. Air Content: 5 percent plus or minus 1.5 percent.

2.10 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116. Furnish batch certificates for each batch discharged and used in the Work.
 - 1. When air temperature is between 85 deg F and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine exposed subgrades and sub-base surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proof-roll prepared sub-base surface below concrete pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.
 - 1. Completely proof-roll sub-base in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
 - 2. Proof-roll with a loaded 10-wheel tandem-axle dump truck weighing not less than 15 tons.
 - 3. Sub-base with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch require correction according to requirements in Division 31 Section "Earth Moving."
- C. Proceed with concrete pavement operations only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

3.2 PREPARATION

- A. Remove loose material from compacted sub-base surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement 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.

3.4 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.
- D. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- E. Zinc-Coated Reinforcement: Use galvanized steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.
- F. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M.
- G. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

3.5 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.
 - 1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.

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- B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.
1. Continue steel reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
 2. Provide tie bars at sides of pavement strips where indicated.
 3. Butt Joints: Use epoxy bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
 5. 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.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
1. Locate expansion joints at intervals of 50 feet, unless otherwise indicated.
 2. Extend joint fillers full width and depth of joint.
 3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
 4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
 5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
 6. Protect top edge of joint filler during concrete placement 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 to match jointing of existing adjacent concrete pavement:
1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 3/8-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.
 2. 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 will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
 3. Doweled Contraction 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.
- E. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 3/8-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast in. Notify other trades to permit installation of their work.
- B. Remove snow, ice, or frost from sub-base surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.
- C. Moisten sub-base 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 requirements for measuring, mixing, transporting, and placing concrete.
- E. Do not add water to concrete during delivery or at Project site.
- F. Do not add water to fresh concrete after testing.
- G. 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.
- H. Consolidate concrete according to ACI 301 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.
- I. Place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay welded wire fabric or fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.
 - 1. Remove and replace concrete that has been placed for more than 15 minutes without being covered by top layer, or use bonding agent if approved by Architect.
- J. Screed pavement surfaces with a straightedge and strike off.
- K. Commence initial floating using bull floats or darbies to impart an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
- L. Curbs and Gutters: When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not approved, remove and replace with formed concrete.

- M. Slip-Form Pavers: When automatic machine placement is used for pavement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce pavement to required thickness, lines, grades, finish, and jointing as required for formed pavement.
 - 1. Compact sub-base and prepare subgrade of sufficient width to prevent displacement of paver machine during operations.
- N. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.
- O. 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 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 mix designs.
- P. Hot-Weather 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 to 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.

3.7 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
 - 1. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

3.8 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 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 by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:
 - 1. Moist 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. Immediately repair any holes or tears during 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.

3.9 PAVEMENT TOLERANCES

- A. Comply with tolerances of ACI 117 and as follows:
 - 1. Elevation: 1/4 inch.
 - 2. Thickness: Plus 3/8 inch, minus 1/4 inch.
 - 3. Surface: Gap below 10-foot-long, unleveled straightedge not to exceed 1/4 inch.
 - 4. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch.
 - 5. Vertical Alignment of Tie Bars and Dowels: 1/4 inch.
 - 6. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2 inch.
 - 7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches.
 - 8. Joint Spacing: 3 inches.
 - 9. Contraction Joint Depth: Plus 1/4 inch, no minus.

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10. Joint Width: Plus 1/8 inch, no minus.

3.10 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.
- B. Allow concrete pavement to cure for 28 days and be dry before starting pavement marking.
- C. Sweep and clean surface to eliminate loose material and dust.
- D. Apply paint with mechanical equipment to produce pavement markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.11 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
 - 1. Testing Frequency: Obtain at least 1 composite sample for each 100 cu. yd. or fraction thereof of each concrete mix placed each day.
 - a. 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.
 - 2. 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 mix. Perform additional tests when concrete consistency appears to change.
 - 3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
 - 4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
 - 5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
 - 6. Compressive-Strength Tests: ASTM C 39/C 39M; test 1 specimen at 7 days and 2 specimens at 28 days.
 - a. A compressive-strength test shall be the average compressive strength from 2 specimens obtained from same composite sample and tested at 28 days.
- C. Strength of each concrete mix will be satisfactory if average of any 3 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.

- D. 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.
- 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 shall 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. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.
- H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.12 REPAIRS AND PROTECTION

- A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.
- B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.
- C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

SECTION 321723 - PAVEMENT MARKINGS

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 painted markings applied to asphalt and concrete pavement.

1.3 PREINSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to marking pavement including, but not limited to, the following:
 - a. Pavement aging period before application of pavement markings.
 - b. Review requirements for protecting pavement markings, including restriction of traffic during installation period.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include technical data and tested physical and performance properties.
- B. Shop Drawings: For pavement markings.
 - 1. Indicate pavement markings, colors, lane separations, defined parking spaces, and dimensions to adjacent work.
 - 2. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.
- C. Samples: For each exposed product and for each color and texture specified; on rigid backing, 8 inches square.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of the City of Raleigh and NC Department of Transportation for pavement-marking work.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for alkyd materials or 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 PAVEMENT-MARKING PAINT

- A. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248; colors complying with FS TT-P-1952.
 1. Color: As indicated.
- B. Pavement-Marking Paint: MPI #32, alkyd traffic-marking paint.
 1. Color: As indicated.
- C. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of less than three minutes.
 1. Color: As indicated.
- D. Pavement-Marking Paint: MPI #97, latex traffic-marking paint.
 1. Color: As indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that pavement is dry and in suitable condition to begin pavement marking according to manufacturer's written instructions.
- B. Proceed with pavement marking only after unsatisfactory conditions have been corrected.

3.2 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

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- B. Allow paving to age for a minimum of 30 days before starting pavement marking.
 - C. Sweep and clean surface to eliminate loose material and dust.
 - D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.
 - 1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to pavement. Mask an extended area beyond edges of each stencil to prevent paint application beyond the stencil. Apply paint so that it cannot run beneath the stencil.
 - 2. Broadcast glass beads uniformly into wet markings at a rate of 6 lb/gal.

3.3 PROTECTING AND CLEANING

- A. Protect pavement markings from damage and wear during remainder of construction period.
- B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 321723

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.
- B. Related Sections:
 - 1. Division 31 Section "Site Clearing" for topsoil stripping and stockpiling.
 - 2. Division 31 Section "Earth Moving" for excavation, filling and backfilling, and rough grading.
 - 3. Division 32 Section "Plants" for border edgings.
 - 4. Division 33 Section "Subdrainage" for subsurface drainage.

1.3 DEFINITIONS

- A. Substantial Completion: The proper installation of seed, sod, and meadow with final grades, mulch and irrigation functioning (if provided) with no indication of widespread plant death. For seeded and meadow areas, the seed must show germination with green shoots visible. It is possible to grant substantial completion to portions of the site without total project completion however all construction activities must be completed in the requested area.
- B. Finish Grade: Elevation of finished surface of planting soil.
- C. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- D. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- E. Planting Soil: The prepared earth existing or imported as specified herein used to backfill lawn or sod areas.
- F. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.

- G. 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.
- H. Turf: A groundcover established from either lawn type seeds, lawn type sod or meadow seeds.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.

1.5 INFORMATIONAL SUBMITTALS

- A. 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.
- B. Qualification Data: For qualified landscape Installer.
- C. Product Certificates: For soil amendments and fertilizers, from manufacturer.
- D. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of turf and meadows during a calendar year. Submit at time of Substantial Completion.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf and meadow establishment.
 - 1. Professional Membership: Installer shall be a member in good standing of National Association of Landscape Professionals, the NC Landscape Contractors' Licensing Board, or AmericanHort.
 - 2. Experience: Three years' experience in turf installation in addition to requirements in Division 01 Section "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: All personnel who handle herbicides and pesticides shall be State licensed, for commercial.
- B. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- C. Soil Analysis: For each un-amended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient content of the soil.

1. Test soil components of Planting Soils Type A, B, C.
2. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
3. Test shall include mechanical analysis of sand, silt and clay components.
4. The soil-testing laboratory shall oversee soil sampling; with depth, location, and number of samples to be taken per instructions from Architect. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
5. Soil tests shall include the following information:
 - a. Percentage of sand, silt and clay.
 - b. Cation exchange capacity.
 - c. Percent of organic matter.
 - d. Stated recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
 - e. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

1.7 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 conformance 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" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. 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 fertilizers, lime, and soil amendments with appropriate certificates.

1.8 PROJECT 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.
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.

Grass Type	Fall Season	Spring Season
Cool season grasses	September 15-December 15	February 1 to May 15
Warm season grasses	Sept 1 to Oct 15	May 15-July 15

B. Water Source:

1. The Owner shall provide water for:
 - a. The construction period until Substantial Completion for the last phase of work.
 - b. Substantial Completion for the last phase of work through the maintenance period.
2. The Contractor shall supply watering labor as follows:
 - a. The construction period until Substantial Completion for the last phase of work.
 - b. Substantial Completion for the last phase of work through the maintenance period.

1.9 MAINTENANCE

- A. Initial Maintenance Service for Lawns [sod and seed areas]: Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after lawns are installed and continue until plantings are acceptably healthy, well established, and deemed satisfactory per Part 3; but for not less than the Construction Maintenance Period below.
1. Construction Maintenance Period: 6 months. The Construction Maintenance Period will begin from the date of Substantial Completion for the last phase of work. Partial areas of turf deemed satisfactory per Part 3 require continued maintenance until all areas are deemed satisfactory per Part 3 and until final date of Construction Maintenance Period; whichever elapses last.
 2. Landscape Maintenance Period - The Landscape Maintenance Period will begin from the date of the Construction Maintenance period described above lapses.
- B. Continuing Maintenance Proposal: Any agreement of an Owner with the Contractor for annual landscape services would begin after the maintenance period elapses.

PART 2 - PRODUCTS

2.1 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species: Seed of grass species as follows, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:

Lawn Type	Seed Mix	Notes
Warm Season	Hybrid Bermuda	

2.2 TURFGRASS SOD

- A. Turfgrass Sod: Number 1 Quality/Premium, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.
- B. Turfgrass Species: Tiffway 417 Bermudagrass

2.3 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
 - 1. Provide lime in form of ground dolomitic limestone or calcitic limestone depending on soil test.

2.4 ORGANIC SOIL AMENDMENTS

- A. Soil Conditioner: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1/2-inch sieve; soluble salt content of 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
 - 1. Organic Matter Content: 70 percent of dry weight.
 - 2. Sources: Agricultural, bark, biosolids; municipal compost; or source-separated or compostable mixed solid waste.
 - a. Free of toxic materials to plant growth
 - b. Free of weed seeds.

2.5 FERTILIZERS

- A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
- B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
- C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
 - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.6 PLANTING SOILS

- A. Planting Soil Type A: Existing, native surface topsoil formed under natural conditions with the duff layer retained during excavation process and stockpiled on-site. Verify suitability of native surface topsoil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth by mechanical screening.
 - 1. Supplement with approved Planting Soil Type B when quantities are insufficient.
 - 2. Mix existing, native surface topsoil with the following soil amendments and fertilizers in the following quantities to produce planting soil:
 - 3. Depth of soil conditioner to mix in Planting Soil: 3/8" to 4".
 - a. Weight of Slow-Release Fertilizer as per soil test.
 - b. Weight of dolomitic limestone as per soil test.
- B. Planting Soil Type B: Imported sandy loam topsoil formed under natural conditions blended with organic matter. Verify suitability of native surface topsoil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
 - 1. Depth of soil conditioner to mix in Planting Soil: 3/8" to 4".
 - 2. Weight of Slow-Release Fertilizer as per soil test
 - 3. Weight of dolomitic limestone as per soil test.
- C. Structural Soil: Imported manufactured structural soil containing components of expanded slate and organic matter. Verify suitability of native surface topsoil to produce viable planting soil.
 - 1. Ratio of soil conditioner to Planting Soil by Volume: 1:6.
 - 2. Weight of Slow-Release Fertilizer as per soil test
 - 3. Weight of dolomitic limestone as per soil test.

2.7 SEED STABILIZATION

- A. Grass seed blankets and coverings:
 - 1. Products for lawn areas: Free of plastic or other non biodegradable materials, seed free, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Excelsior Company, Curlex NetFree
<http://www.americanexcelsior.com/erosioncontrol/products/netfree.php>
 - b. Granite Environmental, Coconut Blanket C4000BD
(<http://www.tdpltd.com/netlon-products/netpave-50.html>)
 - c. Tensar BioNet
(<http://www.nagreen.com/erosion-control-products/bionet-ecbs.php>)
 - 2. Products for storm water management areas: Made from biodegradable jute matting, free of plastic or other non biodegradable materials, seed free.

2.8 MULCHES

- A. General: The Contractor shall select the mulching products that best suit the grass seed selected. Choose from the following mulches:

1. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
 2. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- B. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

2.9 PESTICIDES

- A. General: Pesticide, registered and approved by 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 Non-Selective): 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 Non-Selective): Effective for controlling weed growth that has already germinated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting performance. Notify the Architect immediately and do not start landscape construction operations if:
1. Grades or site features do not match the design.
 2. There is ponding or areas that do not appear to drain
 3. The subsoil contains 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.
 4. If the soils are frozen or moist beyond that required to produce optimal working conditions.
 5. Excessively dry soil that is not workable and which is too dusty.
 6. If the subsoil is over compacted.
 7. If irrigation main and lateral lines have not been installed.
 8. If irrigation main or lateral line trenches have not been compacted.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Erosion Control Seeding Contamination – Evaluate the erosion control seeding used and confirm that potential seed sources will not interfere with the establishment of seeded lawns or meadows. Confer with the General Contractor on usage of erosion control seeding and potential threats to establishing lawns or meadows.

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.
 - 3. Protect areas that should not receive seed such as planting beds.

3.3 TURF AREA PREPARATION

- A. Limit turf subgrade preparation to areas to be planted.
- B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 inches.
 - 1. General
 - a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
 - b. Remove stones larger than 1-1/2 inches in any dimension and sticks, roots, trash, and other extraneous matter.
 - c. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.
 - d. Reduce elevation of planting soil to allow for soil thickness of sod.
 - 2. Apply amendments directly to final grade before loosening. Mix to a total depth of 4".
 - 3. Spread planting soil to a depth of 4 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
 - 4. Thoroughly blend planting soil with organic amendments off-site before spreading
 - 5. Apply lime and fertilizers on surface, and thoroughly blend planting soil.
- C. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:
 - 1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
 - 2. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture.
 - a. Note any areas on the plan that indicate tree root zones. These areas may require the use of hand tools.
- D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.
- E. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- F. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph . Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
1. Do not use wet seed or seed that is moldy or otherwise damaged.
 2. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

- B. Sow seed at the following rates

Hybrid Bermuda	2 lbs per 1000 sf
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- 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 mats where shown 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 rate to form a continuous blanket 1 inch in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.
1. Bond straw mulch by spraying with non-asphalt emulsion at a rate to resist wind and erosion. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.
- F. Protect seeded areas from hot, dry weather or drying winds by applying hydromulch within 4 hours after completing seeding operations.

3.5 HYDROSEEDING – TWO STEP PROCESS

- A. Mix specified seed, commercial fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
1. Mix slurry with nonasphaltic tackifier.
 2. Spray-apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of 1000 lb/acre.

3.6 SODDING

- A. Lay sod within 24 hours of harvesting. 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 subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, 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 angle of slopes exceeding 1:3.

2. Anchor sod on slopes exceeding 1:6 or in the bottom of swales with steel staples spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.

- 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.

3.7 PLUGGING

- A. Plant plugs in holes or furrows, spaced 12 inches apart in both directions. On slopes, contour furrows to near level.

3.8 SPRIGGING

- A. Plant freshly shredded sod sprigs in furrows 1 to 1-1/2 inches deep. Place individual sprigs with roots and portions of stem in moistened soil, 6 inches apart in rows 10 inches apart, and fill furrows without covering growing tips. Lightly roll and firm soil around sprigs after planting.
- B. Broadcast sprigs uniformly over prepared surface at a rate of 10 cu. ft./1000 sq. ft. and mechanically force sprigs into lightly moistened soil.
 1. Spread a 1/4-inch- thick layer of compost mulch on sprigs.
 2. Lightly roll and firm soil around sprigs after planting.
 3. Water sprigs immediately after planting and keep moist by frequent watering until well rooted.

3.9 TURF RENOVATION

- A. Renovate existing turf.
- B. Renovate existing turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.
 1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
 2. Install new planting soil as required.
- C. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.
- D. Remove topsoil containing foreign materials such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.
- E. Mow, dethatch, core aerate, and rake existing turf.
- F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.
- G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.
- H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 4 inches.

1. Confirm that there are no protected root zone areas that would require special procedures.
- I. Apply soil amendments and initial fertilizers required for establishing new turf and mix thoroughly into top 4 inches of existing soil. Install new planting soil to fill low spots and meet finish grades.
- J. Apply seed or sod as shown on the plans and as required for new turf.
- K. Water newly planted areas and keep moist until new turf is established.

3.10 TURF MAINTENANCE

- A. 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. Repair turf as necessary because of settling, erosion or settlement or other processes.
 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 irrigation systems, 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 1/3 of grass height. Remove no more than 1/3 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 inch.
- D. Turf Postfertilization: Apply fertilizer after initial mowing and when grass is dry.
 1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.11 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by 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 3 by 3 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.

3.12 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents in accordance with 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 Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.13 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. 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.
- C. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION 329200

SECTION 329300 - PLANTS

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. Plants.
 - 2. Planting soils.
 - 3. Landscape edgings.
- B. Related Sections:
 - 1. Division 31 Section "Site Clearing" for protection of existing trees and plantings, topsoil stripping and stockpiling, and site clearing.
 - 2. Division 31 Section "Earth Moving" for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.
 - 3. Division 32 Section "Turf and Grasses" for turf (lawn) and meadow planting, hydroseeding, and erosion-control materials.
 - 4. Division 33 Section "Subdrainage" for below-grade drainage of landscaped areas, paved areas, and wall perimeters.

1.3 UNIT PRICES

- A. Work of this Section is affected by unit prices specified in Division 01 Section "Unit Prices."
 - 1. Unit prices apply to authorized work covered by quantity allowances.
 - 2. Unit prices apply to additions to and deletions from Work as authorized by Change Orders.

1.4 DEFINITIONS

- A. Substantial Completion: The proper installation of plant material with final grades, mulch and irrigation (if provided) functioning with no indication of widespread plant death. It is possible to grant substantial completion to portions of the site without total project completion however all construction activities must be completed in the requested area.
- B. Backfill: The planting soil used to replace or the act of replacing earth in an excavation.
- C. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.
- D. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when

removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

- E. Finish Grade: Elevation of finished surface of planting soil.
- F. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- G. Planting Area: Areas to be planted.
- H. Planting Soil: The prepared earth existing or imported as specified herein used to backfill planting areas or to create planting beds.
- I. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
- J. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
- K. Stem Girdling Roots: Roots that encircle the stems (trunks) or main roots of trees below the soil surface.
- L. 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.
- M. 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.
- N. Environmental Conditions: Physical, chemical, and biotic factors affecting ecological community and ability for plants to survive.
- O. Detrimental Conditions: Environmental conditions harmful to the health of proposed plants that can be corrected through supplemental site improvements. Harmful conditions include, but shall not be limited to the following: poor soil, poor drainage, or contaminated soil.

1.5 ACTION SUBMITTALS

- A. Samples for Verification: For each of the following:
 - 1. Mulch: A 1-quart volume of each mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
 - 2. Mineral Mulch: 1 quart volume of each mineral mulch required, in sealed plastic bags labeled with source of mulch. Sample shall be typical of the lot of material to be delivered and installed on the site; provide an accurate indication of color, texture, and makeup of the material.
 - 3. Edging Materials and Accessories: Manufacturer's standard size, to verify color selected.
- B. Soil Analysis: For each un-amended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt,

and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient content of the soil.

1. Test soil components of Planting Soils Type A, B.
2. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
3. Test shall include mechanical analysis of sand, silt and clay components.
4. The soil-testing laboratory shall oversee soil sampling; with depth, location, and number of samples to be taken per instructions from Architect. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
5. Soil tests shall include the following information:
 - a. Percentage of sand, silt and clay.
 - b. Cation exchange capacity.
 - c. Percent of organic matter.
 - d. Stated recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
 - e. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified 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.
- B. Substitutions: The Contractor shall provide the products specified. Changes must be made by written submittal with reason and alternate suggestion.
- C. Environmental Conditions: Prior to contract acceptance by Contractor, submit written description of environmental conditions preventing compliance with warranty.
 1. As applicable, submit detrimental conditions and/or substitutions submittals.
- D. Detrimental Conditions: Per encounter, submit written description of detrimental conditions with recommendation for correcting condition. Include cost estimate.
- E. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of all plants during a calendar year. Submit at time of Substantial Completion.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful establishment of plants.
 1. Professional Membership: Installer shall be a member in good standing of either the National Association of Landscape Professionals or the American Nursery and AmericanHort.
 2. Experience: Five years' experience in landscape installation in addition to requirements in Division 01 Section "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 of the following categories from the following:
 - a. National Association of Landscape Professionals Landscape Industry Certified Exterior Technician.
 - b. National Association of Landscape Professionals Landscape Industry Certified Horticultural Technician.
 - c. Actively licensed by the North Carolina Landscape Contractors' Licensing Board.
 - d. Four-year degree in horticulture, landscape architecture or agronomy.
 5. Selection of plants purchased under allowances will be made by Architect, who will tag plants at their place of growth before they are prepared for transplanting.
- B. Measurements: Measure according to 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.
- C. Plant Pre-Approvals: Utilize the following methods for plant selection.
1. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to the Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 20 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.
- D. Additional Plant Material Observation: Architect may observe plant material either at site before planting or once installed for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.
- E. Substitutions: Substitutions will be permitted only upon submission of proof that a specified plant is not obtainable and with written approval of proposed substitution by Landscape Architect.
1. Contractor shall propose the use of the nearest obtainable variety of the plant having the same essential characteristics that is equal to or greater in size to original specified plant.
- F. Detrimental Conditions: The contractor shall notify the Owner and Landscape Architect in writing of all conditions considered detrimental to growth of plant material. State condition and submit proposal including costs for correcting condition.
- G. Preinstallation Conference: Conduct conference at Project site.
1. The following individuals must be present:

- a. GC Contractor's site representative responsible for the Landscape Contractor's work
- b. The Landscape Contractor's branch manager or Owner and job estimator.
- c. The Project supervisor who will be directly responsible for field work and/or paperwork.

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 conformance 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. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.
- C. Do not prune trees and shrubs before delivery.
- D. Protect bark, branches, and root systems from sunscald, 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.
- E. Handle planting stock by root ball or container.
- F. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F until planting.
- G. 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.
- H. If plants are stored for over 24 hours provide the following:
 1. Set balled stock upright on ground and cover ball with soil, peat moss, sawdust, or other acceptable material to prevent wind, cold, or heat damage to the roots.
 2. Provide shade to shade requiring trees and shrubs.
 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 PROJECT 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. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by Owner or others unless permitted under the following conditions and then only

after arranging to provide temporary services or utilities according to requirements indicated:

1. Notify Owner and Architect no fewer than two days in advance of proposed interruption of each service or utility.
 2. Do not proceed with interruption of services or utilities without Architect's written permission.
- C. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from the date of Substantial Completion.
1. Spring Planting: Feb 15- Apr 15.
 2. Fall Planting: Sep 15 – Jan 1.
- D. 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 and warranty requirements. Do not install plant material if the ground is excessively wet and/or frozen.
- E. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated or acceptable to Landscape Architect.
1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.
- F. Under no circumstances should work proceed prior to the establishment of appropriate grades.
- G. Water Source:
1. The Owner shall provide water for:
 - a. The construction period until Substantial Completion for the last phase of work.
 - b. Substantial Completion for the last phase of work through the maintenance period.
 2. The Contractor shall supply watering labor as follows:
 - a. The construction period until Substantial Completion for the last phase of work.
 - b. Substantial Completion for the last phase of work through the maintenance period.
- H. Unusual Field Conditions: It is the Contractor's responsibility to communicate to the Architect unusual field conditions found at the project site before and during construction. The presence of unusual field conditions such as wind, wetness, soil issues, invasive weeds, will require the Contractor take notes and advise the Architect on how best to remedy the discovery.
- 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, or incidents that are beyond Contractor's control.
 - b. Structural failures including plantings falling, blowing over or settling out of plumb.
 - c. Faulty performance of tree stabilization, edgings, tree grates, or subdrainage.
 - d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
2. Warranty Periods from Date of Substantial Completion:
 - a. Trees, Shrubs, Vines, Ornamental Grasses, Ground Covers, Biennials, Perennials, and Other Plants, metal edges, decorative mulches, landscape drainage features, landscape grading: 12 months.
 - b. Annuals: 3 months.
3. Inspections:
 - a. Perform maintenance checkups at 3-month intervals to verify that plant material is being properly maintained. Notify Owner in writing of any deficiencies.
 - b. Eleven months into warranty period, request in writing a year-end inspection by Owner and Landscape Architect.
4. 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 unhealthy condition at end of warranty period.
 - c. There will be no limitation on replacements of each plant except for losses or replacements due to species intolerance of environmental conditions.
 - 1) Contractor shall notify Landscape Architect in writing of any concerns related to species intolerance of environmental conditions prior to purchase of plant material; otherwise, purchased plant material will be accepted by Contractor as tolerant of environmental conditions. Detrimental conditions shall be corrected prior to installation of plant material and shall not be considered grounds for warranty exclusion.
 - d. Provide extended warranty for period equal to original warranty period, for replaced plant material. As required, continue extended warranty until leaf out to ensure health of replaced material. Plants shall be deemed dead if leaf out does not occur prior to end of spring.
5. All replacements shall be plants of the same kind as originally planted and shall be of size equal to that attained by adjacent plants of the same kind at the time replacement is made. They shall be furnished and planted as specified herein.
6. Removal and replacement shall be at no cost to the Owner.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown 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; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots will be rejected.
 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.
 3. Provide trees from active, consistently aged specimens.
 4. Unless directly specified, provide only trees that are genetic clones of the requested variety.
- B. Select Balled and Burlapped material from nurseries who utilize root pruning practices and have a systematic approach to hardening off newly dug material.
- C. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and forms 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.
- D. Provide small trees and shade trees that are grown on their own roots, not utilizing grafting or budding techniques (unless directed in the plant list).
- E. Provide container plant material that is free from circling roots or pot bound conditions.
- F. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1. Root flare shall be visible before planting.
- G. Labeling: Label at least one 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 the plant as shown on Drawings.
- H. If formal arrangements or consecutive order of plants is shown on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

2.2 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
1. Provide lime in the form of ground dolomitic limestone.

2.3 ORGANIC SOIL AMENDMENTS

- A. Soil Conditioner: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1/2-inch sieve; soluble salt content of 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
1. Pine bark soil conditioner: finely ground, well composted, pine bark mulch with a maximum particle size of 1/4".

2. Organic Matter Content: 70 percent dry weight.
3. Sources: Agricultural, bark, biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
 - a. Free of toxic materials to plant growth
 - b. Free of weed seeds.

2.4 FERTILIZERS

- A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
- B. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.
- C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory. Several different blends may be necessary to meet the requirements.

2.5 PLANTING SOILS

- A. Planting Soil Type A: Existing found on site, native surface topsoil formed under natural conditions with the duff layer retained during excavation process and stockpiled on-site. Verify suitability of native surface topsoil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth by mechanical screening.
 1. Screen native material to remove extraneous materials
 2. Supplement with approved Planting Soil Type **B** when quantities are insufficient.
 3. Mix existing, native surface topsoil with the following soil amendments and fertilizers in the following quantities to produce planting soil:
 - a. Ratio of soil conditioner to Topsoil by Volume: 1:10.
 - b. Weight of Slow-Release Fertilizer as per soil test.
 - c. Weight of dolomitic limestone as per soil test.
- B. Planting Soil Type B: Imported sandy loam topsoil formed under natural conditions blended with organic matter. Verify suitability of native surface topsoil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
 1. Ratio of soil conditioner to Topsoil by Volume: 1:10.
 2. Weight of Slow-Release Fertilizer as per soil test
 3. Weight of dolomitic limestone as per soil test.

2.6 MULCH

- A. Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1/2-inch sieve; soluble salt content of 2 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and suitable as a top dressing of trees and shrubs, consisting of one of the following:

1. Type: Triple shredded hardwood.
2. Color: Natural.

2.7 METAL EDGING

- A. Steel Edging: Standard commercial-steel edging, rolled edge, 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 wide by 5 inches deep.
 2. Stakes: Tapered steel, a minimum of 15 inches long.
 3. Accessories: Standard tapered ends, corners, and splicers.
 4. Finish: Standard paint
 5. Paint Color: Black.

2.8 SUB DRAINAGE

- A. Drainage pipe: 4" black corrugated slotted PE pipe pre-wrapped in a geo-textile fabric capable of filtering clay soil from migrating into the pipe.
- B. Drainage Gravel: Washed, sound crushed stone or gravel complying with ASTM D448.

2.9 MISCELLANEOUS PRODUCTS

- A. Planter Filter Fabric: Nonwoven geotextile manufactured for separation applications and made of polypropylene, polyolefin, or polyester fibers or combination of them.

2.10 HERBICIDES

- A. General: Pesticide registered and approved by 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 Non-Selective): 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 Non-Selective): Effective for controlling weed growth that has already germinated.

2.11 PESTICIDES

- A. General: Pesticide registered and approved by 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.
 1. Use pesticides on an as-needed basis.

2.12 TREE STABILIZATION MATERIALS

- A. Upright and Guy Stakes: Rough-sawn, sound, new hardwood Stakes and Guys:
 - 1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated, pointed at one end.
 - 2. Guys and Tie Wires: ASTM A 641/A 641M, Class 1, galvanized-steel wire, two-strand, twisted, 0.106 inch in diameter.
 - 3. Tree-Tie Webbing: UV-resistant polypropylene or nylon webbing with brass grommets.
 - 4. Flags: Standard surveyor's plastic flagging tape, white, 6 inches long.
- B. Below Grade Root-Ball 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.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.
 - 1. Verify that subgrades are correct prior to spreading topsoil or spreading amendments.
 - 2. Conduct water percolation tests to verify that planting depths and drainage will meet the needs of the plants that have been selected. Inform the Architect of any drainage issues.
 - 3. 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.
 - 4. Along roadways and in landscape islands, remove gravel and asphalt from landscape beds.
 - 5. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
 - 6. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 - 7. Uniformly moisten excessively dry soil that is not workable, and which is too 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 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 Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.

3.3 GENERAL REQUIREMENTS FOR ALL PLANTING TYPES

- A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.
- B. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
- C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
- D. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.
- E. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. 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 the root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
 - 1. Do not excavate deeper than the depth of the root ball, measured from the root flare to the bottom of the root ball.
 - 2. If the area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
 - 3. Maintain required angles of repose of adjacent materials as shown on the Drawings. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
 - 4. Maintain supervision of excavations during working hours.
 - 5. Keep excavations covered or otherwise protected when unattended by Installer's personnel.
 - 6. If subdrainage is shown on Drawings or required under planting areas, insure contact between the root ball and subdrain pipe.
- F. After excavation examine the area for potential drainage difficulties matched to plant varieties and inform the Architect of potential poorly drained areas. Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits. Discuss variations in the depth of planting with the Architect prior to planting.
- G. Fill excavations with water and allow it to percolate away before positioning trees and shrubs.
- H. Set out and space plants according to the planting plans and notes in even rows with triangular spacing unless otherwise indicated.
- I. 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 the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.
- J. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

- K. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- L. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.
- M. Backfill plants with the materials and methods indicated in the Tables below and with the following instructions:
 - 1. 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.
 - 2. 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.
 - 3. Continue backfilling process. Water again after placing and tamping final layer of soil.

3.4 MASS PLANTING AREA REQUIREMENTS

- A. Preparation - Loosen area of planting areas to a minimum depth indicated in the table below. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

Table 1

PLANTING TYPE	TREATMENT AREA	SOIL TREATMENT	BACKFILL FOR EXCAVATION
Shrub and Ground-cover masses	entire planting area	Loosen 8" deep	Use Planting Soil A OR B
Mass perennials	entire planting area	Loosen 8" deep	Use Planting Soil A OR B

- 1. Apply slow-release fertilizer and amendments directly to grade before loosening.
- 2. Thoroughly mix amendments and soil to the depths indicated in Table 1 to produce a uniform, loose, friable planting bed.
- 3. Soil generated from excavations may be used after properly amended as specified.

3.5 MASS PLANTING AREA REQUIREMENTS

- A. Preparation - Loosen subgrade of planting areas to a minimum depth indicated in the table below. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

Table 2

PLANT TYPE	TREATMENT AREA	SUBSOIL TREATMENT	EXCAVATION BACKFILL	PLANTING SOIL* DEPTH
Shrub and Ground-cover masses	entire planting area	Loosen 8" deep	Use Planting Soil*	6"
Mass perennials	entire planting area	Loosen 4" deep	Use Planting Soil*	6"
* Planting Soil Type [A, B]				

1. Spread planting soil to a depth indicated in Table 2 but not less than required to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet. Mix planting soil with the subsoil to form an uneven soil horizon line.
2. Subsoil removed from excavations may not be used as planting soil.

3.6 STORM WATER MANAGEMENT PLANTING STABILIZATION

A. Planting plugs and small container plants in storm water management areas:

1. Prepare the soils according to plans and details including amendments.
2. Micro grade to meet the requirements of the grading plan.
3. Apply jute mat in continuous runs and attach with staples at 30" oc.
4. Cut a small slit in the jute matt and install plugs into soil.
5. If deer or water foul pose a potential threat, use a single staple for each plant across the root ball to prevent the roots from being dislodged.

3.7 SOLITARY TREES AND SHRUBS PLANTING REQUIREMENTS

- #### A. Preparation - Loosen area of planting areas to a minimum depth indicated in the table below. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

Table 3

	Treatment area	Soil treatment	Backfill from excavation
Solitary Trees	10' wider than the root ball	Loosen 12" deep	Use Planting Soil TYPE B
Solitary Shrubs	10' wider than the root ball	Loosen 12" deep	Use Planting Soil TYPE B

1. Soil generated from excavations may be used after properly amended as specified.

3.8 MECHANIZED TREE SPADE PLANTING

- #### A. Supply trees as indicated in the plant list as harvested local trees.
- #### B. The Architect shall tag all trees to be locally harvested with tree spade techniques.
- #### C. Trees shall be planted with an approved mechanized tree spade at the designated locations. Do not use tree spade to move trees larger than the maximum size allowed for a similar field-grown, balled-and-burlapped root-ball diameter according to ANSI Z60.1, or larger than the manufacturer's maximum size recommendation for the tree spade being used, whichever is smaller.
- #### D. When extracting the tree, center the trunk within the tree spade and move tree with a solid ball of earth.

- E. Cut exposed roots cleanly during transplanting operations.
- F. Use the same tree spade to excavate the planting hole as was used to extract and transport the tree.
- G. Plant trees as shown on Drawings, with the following procedures:
 - 1. Lower trees without damaging trunk or major branches
 - 2. Fit the root ball into the hole leaving a minimum gap between the root ball and hole.
 - 3. Fill the remaining gap with a 70% sandy loam topsoil, 30% organic matter and fertilizer blend. Use water to carry mixture to the bottom of the excavation to ensure the gap is full. Allow to drain and return the next day and repeat as necessary until all gaps are filled.
 - 4. Stake the tree with appropriate cabling systems and ensure the tree is plumb.
 - 5. Mulch the tree planting area.
- H. Where possible, orient the tree in the same direction as in its original location.
- I. Supply one slow-release watering bag per 4.5" caliper of tree.

3.9 PLANTING IN TREE PITS

- A. Excavate tree pits according to the details, discard the excavated material.
- B. Install drainage and gravel sumps as shown in the details
- C. Contact the Architect for an inspection of results prior to proceeding.
- D. Once approved, back fill the planter pits with Planter Soil as indicated on the drawings
- E. Plant the plant material as indicated on the drawings. Set the crown so it is a maximum of 1" below the bottom of the tree grate. Install root stabilization.
- F. Install material to appropriate depths, leaving room for the final application of mulch.
 - 1. Root crown shall be exposed after completion.

3.10 PLANT STABILIZATION

- A. Install plant stabilization as follows unless otherwise indicated:

PLANT SIZE	STABILIZATION METHOD
6" in Caliper and Greater	Anchor 4 guys to wood deadmen buried at least 36 inches below grade. Provide turnbuckle and compression spring for each guy wire and tighten securely. Allow enough slack to avoid rigid restraint of tree. Provide soft flexible protection of the trunk from the guy wires. Attach flags to each guy wire, 30 inches above finish grade.
3" to 6" in Caliper	Anchor 3 guys to 30" wood stakes. Install guy wires allowing enough slack to avoid rigid restraint of tree. Provide soft flexible protection of the trunk from the guy wires. Attach flags to each guy wire, 30 inches above finish grade.
Less than 12' tall	Provide two 6' tall hardwood stakes driven into the ground at the edge of the root ball 2' deep. Fasten the tree to the stakes with flexible bands capable of holding the plant steady but not binding.

- B. Root-Ball Stabilization: Install at- or below-grade stabilization system to secure each new planting by the root ball unless otherwise indicated.
 - 1. Refer to planting plan for location of plants to be receiving underground stabilization.
 - 2. Root-Ball Stabilization Device: Install root-ball stabilization system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.

3.11 PLANT PRUNING

- A. Remove only dead, dying, or broken branches. Do not prune for shape.
- B. Do not apply pruning paint to wounds.

3.12 EDGING INSTALLATION

- A. Steel Edging: Install steel edging where indicated according to manufacturer's written instructions. Anchor with steel stakes spaced approximately 30 inches apart, driven below top elevation of edging.
- B. Chiseled Edging: Construct chiseled edge separating mulch areas from lawn as shown in the drawings.

3.13 PLANTING AREA MULCHING

- A. Layout mulch beds carefully with smooth lines and as indicated on the drawings. Mulch backfilled surfaces of planting areas and other areas indicated.
- B. Organic Mulch in Planting Areas: Apply over whole surface of mass planting areas or on isolated plantings as follows:
 - 1. Initial Mulch Application to New Planting Areas:
 - a. 3" minimum depth for trees, shrubs and groundcovers. Do NOT exceed 4 inches depth.
 - b. 1 ½" minimum depth for groundcovers, perennials, and annual beds. Do NOT exceed 2 inches depth.
 - 2. Mulch Application to Existing Planting Areas:
 - a. Supplement mulch as needed to restore entire mulch profile to depths noted for initial mulch application to New Planting Areas.
- C. Do not place mulch within 3 inches of tree or large shrub trunks.

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. Spray or treat as required to keep trees and shrubs free of weeds, insects and disease.

1. Supplement mulch when entire mulch profile is 50 percent of depth required for initial mulch application to New Planting Areas. Restore entire mulch profile to depth indicated in these specifications.
 2. Provide maintenance on all plant material including watering, mulch, pruning and weeding for a period of (12) months starting after Substantial Completion through plant material warranty period.
- B. 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.
1. Supplement entire mulch profile to depth indicated in these specifications. Do not over-apply mulch which can negatively affect the health of plants.
- C. Include the following required action at [12] months from Substantial Completion as part of warranty review:
1. Remove tree staking systems, above and below grade.
 2. Remove tree saucers.
 3. Expose root crowns of all trees planted on the job.

3.15 CLEANUP AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.
- B. 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.
- C. 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.

3.16 DISPOSAL

- A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

END OF SECTION 329300

SECTION 330500 - COMMON WORK RESULTS FOR UTILITIES

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. Piping joining materials.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Sleeves.
 - 5. Identification devices.
 - 6. Grout.
 - 7. Flowable fill.
 - 8. Piped utility demolition.
 - 9. Piping system common requirements.
 - 10. Equipment installation common requirements.
 - 11. Painting.
 - 12. Concrete bases.
 - 13. Metal supports and anchorages.

1.3 DEFINITIONS

- A. Exposed Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.
- B. Concealed Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- C. ABS: Acrylonitrile-butadiene-styrene plastic.
- D. CPVC: Chlorinated polyvinyl chloride plastic.
- E. PE: Polyethylene plastic.
- F. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Dielectric fittings.
 - 2. Identification devices.
- B. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Steel Piping Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes 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.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

- A. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- B. Coordinate installation of identifying devices after completing covering and painting if devices are applied to surfaces.
- C. Coordinate size and location of concrete bases. Formwork, reinforcement, and concrete requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness, unless otherwise indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- G. Solvent Cements for Joining Plastic Piping:
 - 1. ABS Piping: ASTM D 2235.
 - 2. CPVC Piping: ASTM F 493.
 - 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 - 4. PVC to ABS Piping Transition: ASTM D 3138.
- H. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.2 TRANSITION FITTINGS

- A. Transition Fittings, General: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
- B. Transition Couplings NPS 1-1/2 and Smaller:
 - 1. Underground Piping: Manufactured piping coupling or specified piping system fitting.
 - 2. Aboveground Piping: Specified piping system fitting.

C. AWWA Transition Couplings NPS 2 and Larger:

1. Description: AWWA C219, metal sleeve-type coupling for underground pressure piping.

D. Plastic-to-Metal Transition Fittings:

1. Description: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint or threaded] end.

E. Plastic-to-Metal Transition Unions:

1. Description: MSS SP-107, PVC four-part union. Include brass or stainless-steel threaded end, solvent-cement-joint or threaded plastic end, rubber O-ring, and union nut.

F. Flexible Transition Couplings for Underground Non-pressure Drainage Piping:

1. Description: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

2.3 DIELECTRIC FITTINGS

A. Dielectric Fittings, General: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:

1. Description: Factory fabricated, union, NPS 2 and smaller.
 - a. Pressure Rating: 250 psig at 180 deg F.
 - b. End Connections: Solder-joint copper alloy and threaded ferrous; threaded ferrous.

C. Dielectric Flanges:

1. Description: Factory-fabricated, bolted, companion-flange assembly, NPS 2-1/2 to NPS 4 and larger.
 - a. Pressure Rating: 175 psig minimum.
 - b. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Kits:

1. Description: Nonconducting materials for field assembly of companion flanges, NPS 2-1/2 and larger.
 - a. Pressure Rating: 150 psig minimum.
 - b. Gasket: Neoprene or phenolic.
 - c. Bolt Sleeves: Phenolic or polyethylene.

d. Washers: Phenolic with steel backing washers.

E. Dielectric Couplings:

1. Description: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining, NPS 3 and smaller.
 - a. Pressure Rating: 300 psig at 225 deg F.
 - b. End Connections: Threaded.
2. Description: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining.
 - a. Pressure Rating: 300 psig at 225 deg F.
 - b. End Connections: Threaded or grooved.

2.4 SLEEVES

- A. Mechanical sleeve seals for pipe penetrations are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- C. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized, plain ends.
- D. Cast-Iron Sleeves: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- E. Molded PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe Sleeves: ASTM D 1785, Schedule 40.
- G. Molded PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.5 IDENTIFICATION DEVICES

- A. General: Products specified are for applications referenced in other Division 33 Sections. If more than single type is specified for listed applications, selection is Installer's option.
- B. Equipment Nameplates: Metal permanently fastened to equipment with data engraved or stamped.
 1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and essential data.
 2. Location: Accessible and visible.

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- C. Stencils: Standard stencils prepared with letter sizes complying with recommendations in ASME A13.1. Minimum letter height is 1-1/4 inches for ducts, and 3/4 inch for access door signs and similar operational instructions.
1. Material: Fiberboard or Brass.
 2. Stencil Paint: Exterior, oil-based, alkyd-gloss black enamel, unless otherwise indicated. Paint may be in pressurized spray-can form.
 3. Identification Paint: Exterior, oil-based, alkyd enamel in colors according to ASME A13.1, unless otherwise indicated.
- D. Snap-on Plastic Pipe Markers: Manufacturer's standard preprinted, semirigid, snap-on type. Include color-coding according to ASME A13.1, unless otherwise indicated.
- E. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, color-coded, pressure-sensitive-vinyl type with permanent adhesive.
- F. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers, extending 360 degrees around pipe at each location.
- G. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers, at least three times letter height and of length required for label.
- H. Lettering: Manufacturer's standard preprinted captions as selected by Architect.
- I. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
1. Arrows: Either integrally with piping system service lettering to accommodate both directions of flow, or as separate unit on each pipe marker to indicate direction of flow.
- J. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive vinyl tape, at least 3 mils thick.
1. Width: 1-1/2 inches on pipes with OD, including insulation, less than 6 inches; 2-1/2 inches for larger pipes.
 2. Color: Comply with ASME A13.1, unless otherwise indicated.
- K. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch sequenced numbers. Include 5/32-inch hole for fastener.
1. Material: 0.032-inch-thick, polished brass or aluminum.
 2. Material: 0.0375-inch-thick stainless steel.
 3. Material: 3/32-inch-thick plastic laminate with 2 black surfaces and a white inner layer.
 4. Material: Valve manufacturer's standard solid plastic.
 5. Size: 1-1/2 inches in diameter, unless otherwise indicated.
 6. Shape: As indicated for each piping system.
- L. Valve Tag Fasteners: Brass, wire-link or beaded chain; or brass S-hooks.

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- M. Engraved Plastic-Laminate Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.
1. Engraving: Engraver's standard letter style, of sizes and with terms to match equipment identification.
 2. Thickness: 1/8 inch, unless otherwise indicated.
 3. Thickness: 1/16 inch, for units up to 20 sq. in. or 8 inches in length, and 1/8 inch for larger units.
 4. Fasteners: Self-tapping, stainless-steel screws or contact-type permanent adhesive.
- N. Plastic Equipment Markers: Manufacturer's standard laminated plastic, in the following color codes:
1. Green: Cooling equipment and components.
 2. Yellow: Heating equipment and components.
 3. Brown: Energy reclamation equipment and components.
 4. Blue: Equipment and components that do not meet criteria above.
 5. Hazardous Equipment: Use colors and designs recommended by ASME A13.1.
 6. Terminology: Match schedules as closely as possible. Include the following:
 - a. Name and plan number.
 - b. Equipment service.
 - c. Design capacity.
 - d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.
 7. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.
- O. Plasticized Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with mat finish suitable for writing.
1. Size: 3-1/4 by 5-5/8 inches.
 2. Fasteners: Brass grommets and wire.
 3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
- P. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in piped utility identification with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of piped utility systems and equipment.
1. Multiple Systems: Identify individual system number and service if multiple systems of same name are indicated.

2.6 GROUT

- A. Description: ASTM C 1107, Grade B, non-shrink and non-metallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

2.7 FLOWABLE FILL

- A. Description: Low-strength-concrete, flowable-slurry mix.
 - 1. Cement: ASTM C 150, Type I, portland.
 - 2. Density: 115- to 145-lb/cu. ft.
 - 3. Aggregates: ASTM C 33, natural sand, fine and crushed gravel or stone, coarse.
 - 4. Aggregates: ASTM C 33, natural sand, fine.
 - 5. Admixture: ASTM C 618, fly-ash mineral.
 - 6. Water: Comply with ASTM C 94/C 94M.
 - 7. Strength: 100 to 200 psig at 28 days.

PART 3 - EXECUTION

3.1 PIPED UTILITY DEMOLITION

- A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove piped utility systems, equipment, and components indicated to be removed.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2. Piping to Be Abandoned in Place: Drain piping. Fill abandoned piping with flowable fill, and cap or plug piping with same or compatible piping material.
 - 3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - 4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make operational.
 - 5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 DIELECTRIC FITTING APPLICATIONS

- A. Dry Piping Systems: Connect piping of dissimilar metals with the following:
 - 1. NPS 2 and Smaller: Dielectric unions.
 - 2. NPS 2-1/2 to NPS 12: Dielectric flanges or dielectric flange kits.
- B. Wet Piping Systems: Connect piping of dissimilar metals with the following:
 - 1. NPS 2 and Smaller: Dielectric couplings or dielectric nipples.
 - 2. NPS 2-1/2 to NPS 4: Dielectric nipples.
 - 3. NPS 2-1/2 to NPS 8: Dielectric nipples or dielectric flange kit].
 - 4. NPS 10 and NPS 12: Dielectric flange kits.

3.3 PIPING INSTALLATION

- A. Install piping according to the following requirements and Division 33 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on the Coordination Drawings.
- C. 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.
- D. Install piping to permit valve servicing.
- E. Install piping at indicated slopes.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. Select system components with pressure rating equal to or greater than system operating pressure.
- I. Sleeves are not required for core-drilled holes.
- J. Permanent sleeves are not required for holes formed by removable PE sleeves.
- K. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of equipment areas or other wet areas 2 inches above finished floor level.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - a. PVC or Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.

- L. Verify final equipment locations for roughing-in.
- M. Refer to equipment specifications in other Sections for roughing-in requirements.

3.4 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 33 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Threaded 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. Join pipe fittings and valves as follows:
 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- E. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- G. Grooved Joints: Assemble joints with grooved-end pipe coupling with coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
- H. Soldered Joints: Apply ASTM B 813 water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy (0.20 percent maximum lead content) complying with ASTM B 32.
- I. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- J. Pressure-Sealed Joints: Assemble joints for plain-end copper tube and mechanical pressure seal fitting with proprietary crimping tool to according to fitting manufacturer's written instructions.
- K. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 appendixes.
3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
5. PVC Non-pressure Piping: Join according to ASTM D 2855.
6. PVC to ABS Non-pressure Transition Fittings: Join according to ASTM D 3138 Appendix.

L. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

M. Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D 3212.

N. Plastic Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End PE Pipe and Fittings: Use butt fusion.
2. Plain-End PE Pipe and Socket Fittings: Use socket fusion.

O. Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.5 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Install dielectric fittings at connections of dissimilar metal pipes.

3.6 EQUIPMENT INSTALLATION

A. Install equipment level and plumb, unless otherwise indicated.

B. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference with other installations. Extend grease fittings to an accessible location.

C. Install equipment to allow right of way to piping systems installed at required slope.

3.7 PAINTING

A. Painting of piped utility systems, equipment, and components is specified in Division 09 painting Sections.

- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.8 IDENTIFICATION

- A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.
 - 1. Stenciled Markers: According to ASME A13.1.
 - 2. Plastic markers, with application systems. Install on insulation segment if required for hot noninsulated piping.
 - 3. Locate pipe markers on exposed piping according to the following:
 - a. Near each valve and control device.
 - b. Near each branch, excluding short takeoffs for equipment and terminal units. Mark each pipe at branch if flow pattern is not obvious.
 - c. Near locations where pipes pass through walls or floors or enter inaccessible enclosures.
 - d. At manholes and similar access points that permit view of concealed piping.
 - e. Near major equipment items and other points of origination and termination.
- B. Equipment: Install engraved plastic-laminate sign or equipment marker on or near each major item of equipment.
 - 1. Lettering Size: Minimum 1/4 inch high for name of unit if viewing distance is less than 24 inches), 1/2 inch high for distances up to 72 inches), and proportionately larger lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.
 - 2. Text of Signs: Provide name of identified unit. Include text to distinguish among multiple units, inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
- C. Adjusting: Relocate identifying devices that become visually blocked by work of this or other Divisions.

3.9 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

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4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete"

3.10 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor piped utility materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.11 GROUTING

- A. Mix and install grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 330500

SECTION 334100 - STORM UTILITY DRAINAGE PIPING

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 gravity-flow, non-pressure storm and foundation drainage outside the building, with the following components:
 - 1. PVC pipe.
 - 2. Reinforced concrete pipe.
 - 3. Ductile iron pipe.
 - 4. HDPE pipe (perforated and solid).
 - 5. Cleanouts.
 - 6. Precast concrete manholes and other drainage structures.
 - 7. Cast iron gratings and frames including trench drain.
 - 8. Excavation and backfill for pipe and drainage structures.
- B. Related Sections include the following:
 - 1. Division 2 Section "Earth Moving" properly prepared subgrade.

1.3 SUBMITTALS

- A. Product Data: For the following:
 - 1. Special pipe fittings.
 - 2. All drains, including trench drains and rims.
 - 3. All pipes used.
- B. Shop Drawings: For the following:
 - 1. Catch basins and stormwater inlets, trench drains, and manholes. Include plans, elevations, sections, details, and frames, covers, and grates.
- C. Coordination Drawings: Show pipe sizes, locations and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
- D. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1 inch equals 50 feet and vertical scale of not less than 1 inch equals 5 feet. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.
- E. Field quality-control test reports.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect pipe, pipe fittings, and seals from dirt and damage.
- B. Handle catch basins, curb inlets, trench drain, and manholes according to manufacturer's written rigging instructions.
- C. Do not store plastic components in direct sunlight.

1.5 PROJECT CONDITIONS

- A. Interruption of Existing Storm Drainage 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 Architect no fewer than five (5) days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without Architect's and Owner's written permission.

1.6 PERFORMANCE REQUIREMENTS

- A. Storm drainage systems are to be in accordance with applicable sections and paragraphs of the North Carolina Department of Transportation's "Standard Specifications for Roads and Structures" or the "City of Raleigh Standard Details".
- B. Erosion Control: Provide all necessary erosion control devices as per "City of Raleigh Standards" to protect loss of silt from project site.

PART 2 - PRODUCTS

2.1 PVC PIPE AND FITTINGS

- A. PVC Pipe: AWWA C900, Class 200, for gasketed joints and using ASTM F 477, elastomeric seals.
 - 1. Fittings NPS 4 to NPS 8: PVC pressure fittings complying with AWWA C907, for gasketed joints and using ASTM F 477, elastomeric seals.
 - 2. Perforated pipe for French drains.
 - 3. Solid pipe between French drains and drainage structures, where shown.
 - 4. PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.2 REINFORCED CONCRETE PIPE AND FITTINGS

- A. Reinforced-Concrete Pipe (RCP): Shall conform to AASHTO Specification M-170-81-1 and ASTM C 76, Class III, as indicated on the drawings. Joints shall be standard tongue and groove ends and gasketed joints with ASTM C443 rubber gaskets.

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1. All applicable articles and paragraphs in the City of Raleigh Standard Specifications shall apply.

2.3 DUCTILE IRON PIPE (DIP)

- A. Provide AWWA C-151, Class 51 pipe for push-on joints.
 1. Diameter: 6 and 8 inches as shown.
 2. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.
 3. Compact Fittings: AWWA C153, for push-on joints.
 4. Gaskets: AWWA C111, rubber.
 5. Recycled Content: Not less than 80%.

2.4 HDPE PIPE AND FITTINGS

- A. Corrugated HDPE Drainage Pipe and Fittings: ASTM F2648, with smooth waterway for coupling joints.
 1. Watertight Joints: According to the requirements of ASTM D3212.
 2. Watertight Gaskets: According to the requirements of ASTM F477.
 3. Watertight Fittings: Fittings shall conform to ASTM F2306.
 4. Field Pipe and Joint Performance: Any testing shall be in accordance with ASTM F2487.
 5. Recycled Content: Not less than 25%.
- B. Perforated HDPE Drainage Pipe and Fittings: ASTM F810, with smooth waterway for coupling joints.
 1. Material Property: According to the requirements of ASTM D3350.
 2. Installation: According to ASTM D2321 and manufacturer's written specifications.

2.5 PVC PIPE AND FITTINGS

1. PVC Water-Service Pipe and Fittings: ASTM D 1785, Schedule 80 pipe, with plain ends for solvent-cemented joints with ASTM D 2467, Schedule 80, socket-type fittings.

2.6 CONCRETE PIPE AND FITTINGS

- A. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76, with groove and tongue ends and gasketed joints with ASTM C 443 rubber gaskets.
 1. Class III, Wall.
 2. Class IV, Wall.

2.7 NONPRESSURE-TYPE PIPE COUPLINGS

- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground non-pressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
- B. Sleeve Materials:
 1. For Concrete Pipes: ASTM C 443, rubber.

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2. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 3. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

2.8 CLEANOUTS

- A. Gray-Iron Cleanouts: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside caulk or spigot connection and countersunk, tapered-thread, brass closure plug.
 1. Top-Loading Classification(s): Heavy duty.
 2. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

2.9 DRAINS

- A. Gray-Iron Trench Drains: ASME A112.21.1M, 6-inch-wide top surface, rectangular body with anchor flange or other anchoring device, and rectangular secured grate.
 1. Top-Loading Classification(s): Heavy duty.

2.10 MANHOLES

- A. General: Manholes are to conform to the following standards:
 1. Manholes shall conform to City of Raleigh Standard 30.05.
- B. Standard Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
 1. Diameter: 48 inches minimum, unless otherwise indicated.
 2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
 3. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
 4. Riser Sections: 4-inch minimum thickness, and lengths to provide depth indicated.
 5. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
 6. Joint Sealant: ASTM C 990, butyl rubber.
 7. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
 8. Steps: ASTM A 615/A 615M, deformed, 1/2-inch min. steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals.
 9. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and diameter matching manhole frame and cover. Include sealant recommended by ring manufacturer.
 10. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.

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11. Manhole Frames and Covers: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch-minimum width flange and 26-inch-diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
 - a. Material: ASTM A 48, Class 35 gray iron, unless otherwise indicated.
 - C. Designed Precast Concrete Manholes: Description: ASTM C 913; designed according to ASTM C 890 for A-16 (AASHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.
 1. Ballast: Increase thickness of one or more precast concrete sections or add concrete to manhole as required to prevent flotation.
 2. Joint Sealant: ASTM C 990, butyl rubber.
 3. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
 4. Steps: ASTM A 615/A 615M, deformed, ½-inch min. 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 16-inch intervals.
 5. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and diameter matching manhole frame and cover. Include sealant recommended by ring manufacturer.
 6. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
 7. Manhole Frames and Covers: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch minimum width flange and 26-inch-diameter cover. Included indented top design with lettering cast into cover, using wording equivalent to "Storm Sewer".
 - a. Material: ASTM A 48, Class 35 gray iron, unless otherwise indicated.

2.11 CONCRETE

- A. General: Cast-in-place concrete is specified in Section 03300.

2.12 CATCH BASINS

- A. Standard Precast Concrete Catch Basins: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
 1. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
 2. Riser Sections: 4-inch minimum thickness, 48-inch diameter, and lengths to provide depth indicated.
 3. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
 4. Joint Sealant: ASTM C 990, butyl rubber.
 5. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
 6. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch- diameter frame and grate.

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7. Steps: 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 16-inch intervals.
 8. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.
- B. Designed Precast Concrete Catch Basins: ASTM C 913, precast, reinforced concrete; 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.
1. Joint Sealants: ASTM C 990, butyl rubber.
 2. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
 3. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch- diameter frame and grate.
 4. Steps: 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 16-inch intervals.
 5. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.
- C. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include flat grate with small square or short-slotted drainage openings.
1. Size: 24 by 24 inches (610 by 610 mm) minimum unless otherwise indicated.
 2. Grate Free Area: Approximately 50 percent unless otherwise indicated.
- D. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include 24-inch ID by 7- to 9-inch riser with 4-inch minimum width flange, and 26-inch-diameter flat grate with small square or short-slotted drainage openings.
1. Grate Free Area: Approximately 50 percent, unless otherwise indicated.
- 2.13 STORMWATER INLETS
- A. Frames and Grates: Heavy-duty frames and grates according to utility standards.
- 2.14 EARTH FILL
- A. Backfill shall be as specified in Division 2 Section "Earthwork" and be substantially free from organic materials, loam, wood, trash and other objectionable materials which may be compressible, or which cannot be properly compacted. Additionally, the fill material shall not contain stones or rocks larger than 2 inches in diameter, blocks, broken concrete, masonry rubble, snow, ice, frozen earth or other similar materials. Compact in layers as specified in Division 2 Section "Earthwork".

PART 3 - EXECUTION

3.1 EXCAVATION

- A. General: Only that portion of line which can be laid and backfilled in that day will be excavated at one time. Excavation shall be made to pipe grade by machine or hand as required and shall be left for fine grading by the pipe laying crew.
- B. Width of trench shall be as required to install storm drainage lines as sized on drawings. Trench width shall be kept to that required for safe construction. All applicable Occupational Safety and Health Administration (OSHA) regulations such as trench depth and sheathing shall be followed by the Contractor.
- C. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe elevation to allow for bedding course. Hand excavate for bell of pipe.
- D. All trenching and backfilling work shall conform to the N.C. Department of Labor, Division of Standards and Inspection Construction Bureau, Article No. XXI, Bulletin No. 1.
- E. Construction Stakes: Storm drainage materials shall be installed by the Contractor to the proper line and grade. Contractor to set construction stakes to define proper line and grade, and verify all lines and grades before commencing any digging operations. This shall include verification of any existing inverts indicated.

3.2 SUBGRADE INSPECTION

- A. Notify Architect when excavations have reached required subgrade.
- B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed on the unit price basis.

3.3 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location, arrangement and type of underground storm drainage 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.
- B. 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 use of lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

- D. 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.
- E. Install gravity-flow, non-pressure drainage piping according to the following:
 - 1. Install piping pitched down in direction of flow at minimum slope of 1 percent, unless otherwise indicated.
 - 2. Install piping NPS 6 and larger with restrained joints at tee fittings and changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
 - 3. Install piping with 12-inch minimum cover (to top of subgrade).
 - 4. Install ductile-iron culvert piping according to ASTM A 716.
 - 5. Install ductile-iron and special fittings according to AWWA C600 or AWWA M41.
 - 6. Install HDPE corrugated sewer piping according to CPPA's Recommended Installation Practices for Corrugated Polyethylene Pipe and Fittings."
 - 7. Install PVC pressure piping according to AWWA M23 or ASWWTM D 2774 and ASTM F 1668.
 - 8. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

3.4 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, non-pressure drainage piping according to the following:
 - 1. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
 - 2. Join ductile-iron and special fittings according to AWWA C600 or AWWA M41.
 - 3. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric gasket joints.
 - 4. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.
 - 5. Join corrugated HDPE piping according to ACPA 100 and the following:
 - a. Use waterproof couplings.

3.5 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extension from sewer pipe to cleanout at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
 - 1. Use heavy-duty, top-loading classification cleanouts in all areas.
- B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches (below paver/concrete sidewalk areas) deep.
- C. Set cleanout frames and covers in concrete pavement with tops flush with pavement surface.

3.6 CATCH BASIN INSTALLATION

- A. Construct catch basins to sizes and shapes indicated.

- B. Set frames and grates to elevations indicated.

3.7 MANHOLE INSTALLATION

- A. General: Install manholes, complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections according to ASTM C 891.
- C. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 4 inches above finished surface elsewhere, unless otherwise indicated.

3.8 STORMWATER INLET AND OUTLET INSTALLATION

- A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.
- B. Construct riprap of broken stone, as indicated.
- C. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.

3.9 UTILITY TRENCH BACKFILL

- A. Place backfill on subgrades free of mud, frost, snow or ice.
 - 1. Conform to applicable City of Raleigh Standards.
- B. 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.
- C. 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 3 Section "Cast-in-Place Concrete".
- D. 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.
- E. Place and compact initial backfill of subbase material, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the utility pipe or conduit.
 - 1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping and conduit. Coordinate backfilling with utilities testing.
 - 2. Compaction density and testing shall be as specified in Section 312000 "Earth Moving".
- F. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches over the utility pipe or conduit.
- G. Backfill voids with satisfactory soil while installing and removing shoring and bracing.

- H. Place and compact final backfill of satisfactory soil to final subgrade elevation.
- I. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.

3.10 PROTECTION OF EXISTING FACILITIES

- A. Contractor shall protect and maintain all existing surface or subsurface utilities and repair any damage done to these utilities during the course of the work.

3.11 FIELD QUALITY CONTROL

- A. 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. 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. Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 - 2. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 - 3. Re-inspect and repeat procedure until results are satisfactory.

3.12 CLEANING

- A. Clean interior of piping of dirt and superfluous materials.

END OF SECTION 334100